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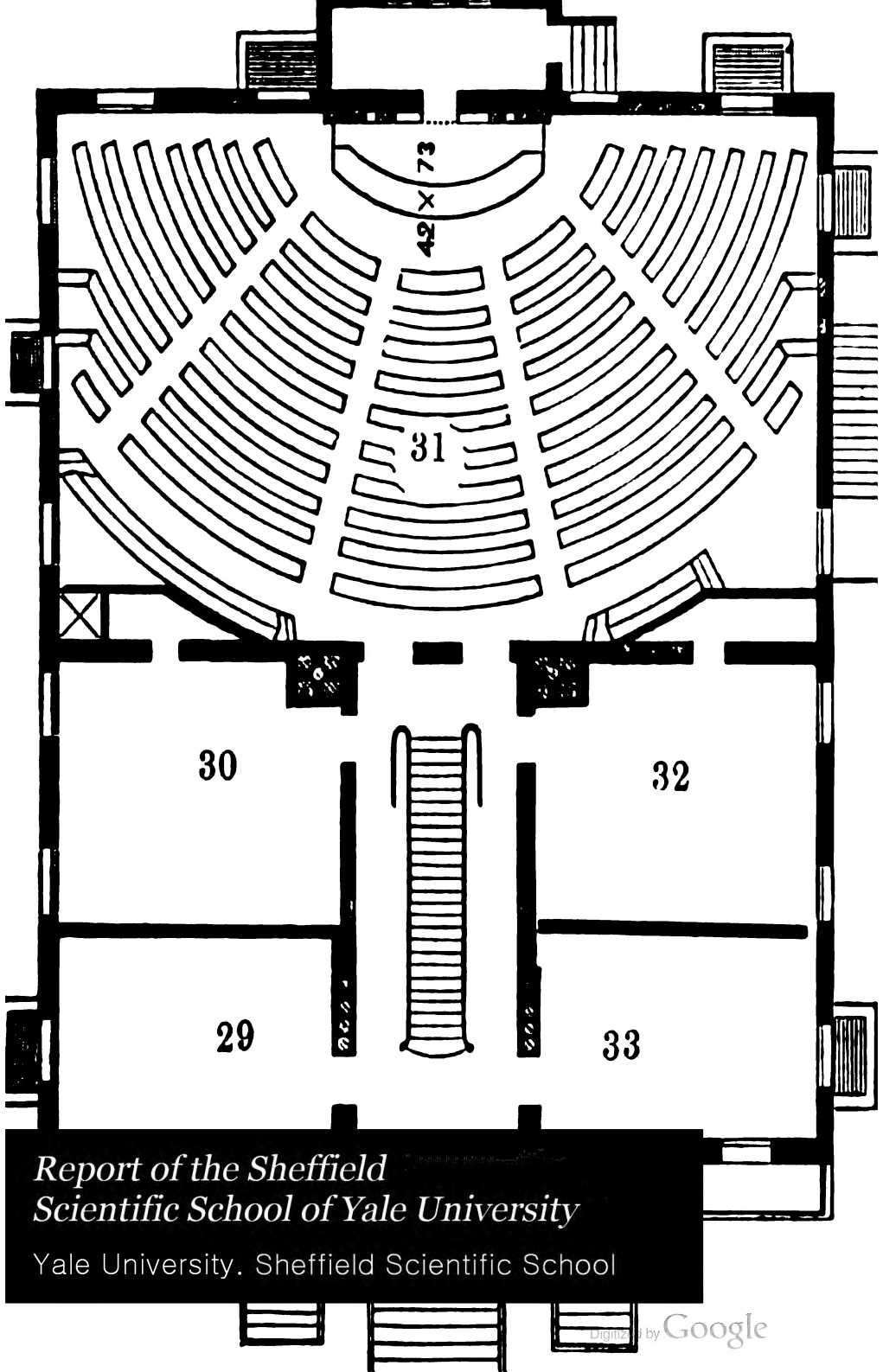

Report of the Sheffield Scientific School of Yale University

Yale University. Sheffield Scientific School

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1872-3

EIGHTH

ANNUAL REPORT

OF THE

Sheffield Scientific Sch

OF

YALE COLLEGE,

1872–3.

PRINTED BY ORDER OF THE GENERAL ASSEMBL

NEW HAVEN:
PRINTED BY TUTTLE, MOREHOUSE & TAYLOR.
1873.

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State Board of Visitors:

CONSTITUTING, WITH THE SECRETARY OF THE SCHOOL, THE BOARD FOR THE APPOINTMENT OF STATE STUDENTS.

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LIEUTENANT GOVERNOR.

His Honor MORRIS TYLER, New Haven.

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Hon. WILLIAM E. DODGE, New York City.

SECRETARY AND TREASURER OF THE SCHOOL.

GEORGE J. BRUSH.

JANITOR OF SHEFFIELD HALL.

ANTON PFEIFER, 55 Lock St.

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EIGHTH

ANNUAL REPORT

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1872–3.

PRINTED BY ORDER OF THE GENERAL ASSEMBLY.

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REPORT OF THE STATE BOARD OF VISITORS.

To the General Assembly of the State of Connecticut:

THE undersigned, on behalf of the Board of Visitors, whose duty is to annually report upon the condition of the Sheffield Scientific School, respectfully state that they have visited the institution twice during the past year.

At the last Commencement twenty-six persons were graduated in the various departments, and in September one hundred and one new students were admitted as members of the School, eighty of whom entered the Freshman Class. The aggregate number of students for the current year is two hundred and one.

The State Scholarships, twenty-seven in number, have been entirely full for several years past, and although all applications for scholarships have been granted up to this time, it is evident that hereafter there will be more applications than vacancies, and that a strict conformance with the law must be observed in the appointments. The act of legislature requires, "in case there are more applications for the bounty of the State than there are vacancies to be filled on the part of the State, said Board shall give the preference to such young men as are fitting themselves for agriculture and mechanical or manufacturing occupations in life, who are or shall become orphans through the death of a parent in the naval or military service of the United States; next to them, such as are most in need of pecuniary assistance; and, furthermore, they shall provide that the appointments shall be distributed, as far as practicable, among the several counties, in proportion to their population."

The new building, the commencement of which was announced in the last report, is now nearly completed, and will be entirely ready for use this summer. It is a very substantial structure,

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and is finished and equipped in the most complete manner. The building, with the lot on which it stands, is a gift to the institution from its noble and munificent patron, Mr. JOSEPH E. SHEFFIELD. A detailed description of it will be found in the accompanying report of the Governing Board.

During the last year the School has lost the valuable and valued services of Professor Gilman, who has been called to another field of usefulness. We regret his leaving, but congratulate the State of California on the accession it has received. We are glad to state, however, that the School has been more than fortunate in inducing General Walker, late Commissioner of Indian Affairs, and Superintendent of the United States Census, to accept the vacant chair. In him the institution gains a professor whose past furnishes unmistakable promise for the future, and who will be a worthy successor of the man whose place he takes.

The benefit which the Scientific School has conferred upon the State in turning out young men who, on leaving the institution, are enabled to assume the position of leaders in their several callings, and of educators of the people to a higher grade of culture, increasing the productive brain capacity as well as the material wealth of the country, cannot be estimated in dollars and cents. From all parts of the country come back most favorable reports of the graduates who have been sent out, and their influence, already great, is constantly on the increase. The people of this State cannot do too much for an institution which has already done and is continuing to do so much for them, by developing the material resources of Connecticut, and by extending its reputation throughout the entire country.

In behalf of the Board,

MARSHALL JEWELL, *Chairman.*

BIRDSEY G. NORTHROP,
Secretary of the State Board of Education.

NEW HAVEN, MAY, 1873.

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ANNUAL STATEMENT

OF THE

GOVERNING BOARD.

In presenting their Eighth Annual Statement in respect to the progress of the Sheffield Scientific School of Yale College, the Governing Board refer with special pleasure to that manifestation of public confidence in their work which is exhibited by the rapidly increasing number of students in attendance. This number had been steadily growing for several years past, and had at length become so large as to task the somewhat limited resources of the School for their proper accommodation; and accordingly a part of the work has been for some time necessarily done off the ground. In particular, the instruction in Dynamic Engineering had been given in the Art School building, and a great part of the work in Natural History had been carried on in the building originally used for the Trumbull collection of paintings. For the purpose of providing suitable accommodations for these, and of furnishing relief to the other class-rooms already crowded to their utmost capacity, Mr. Joseph E. Sheffield determined to add another to the munificent gifts already made by him, by which the success of this School has been in the past mainly secured. Early in the beginning of last year, therefore, he began entirely at his own motion and expense the construction and equipment of a new edifice, which stands on Prospect street, directly north of the present hall, and which is to be devoted to lecture-rooms, class-rooms, and collections. This building is now at the point of completion, and will be entirely finished before the end of the summer term; indeed, use is already made of a number of the rooms. The gift, it may be added, was as timely as it was munificent; for the increase of the last entering class was so unprecedented, and so entirely beyond the expectations of the Governing Board, that it has severely strained their resources to meet the demand upon them for room. In accordance with the promise made in the last annual report, a detailed account of the new building is here subjoined.

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Description of North Sheffield Hall.

The plan of the building, arrangement of rooms, character of finish, and other general features, were decided on by a committee of the Trustees appointed by Mr. Sheffield, and, with his approval, an architect, Mr. J. C. Cady of New York, was employed to furnish designs for the exterior faces and for the details of the interior work.

Contracts for the execution of the work were then made by Mr. Sheffield with Messrs. Perkins & Chatfield for the masonry, and with Mr. Charles Thompson for the carpenter's work, and the building was begun early in the spring of last year. It occupies a lot on Prospect street about two hundred feet north of Sheffield Hall. The lot has a front of one hundred feet and a depth of one hundred and ten feet.

The new building has a front of seventy-six feet on Prospect street, and a depth of eighty-four feet, standing back from the street sixteen feet.

The plan is rectangular, and it has substantially five stories,—a basement of eleven feet in height, first, second and third stories, each fourteen feet high in the clear, and an attic or fourth story nine and a half feet high in the clear. The foundation walls to the water-table are of brown stone in courses, rock-faced. The water-table, window and door sills are of blue stone, and the main walls of red brick; white fire bricks and blue stone bricks being employed in band courses, in the arches of the openings, and in the cornices.

The front porch constitutes the only ornamental work exterior to the main walls. This part of the structure and the chimney caps are built of a light colored Amherst (Ohio) stone.

The general plan of the interior arrangement of rooms is based on that of the first story, provision being made for a large lecture-room in the rear part of this particular one, extending across the whole rear side of the building, and occupying nearly one-half of the story. This lecture-room has a capacity for seating about four hundred and fifty persons. A hall sixteen feet wide from the front entrance communicates with this lecture-room, and affords room for the main staircase to the upper stories. On each side of this hall there are two recitation-rooms, one $12'.5'' \times 27'.5''$ and one $12'.11'' \times 26'.9''$, making four recitation-rooms and a large lecture-room on the first floor.

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NORTH SHEFFIELD HALL.

Plan of the Main Story.

No. 29. Recitation-room.
30. Recitation-room.
31. General Lecture-room.
32. Recitation-room.
33. Recitation-room.

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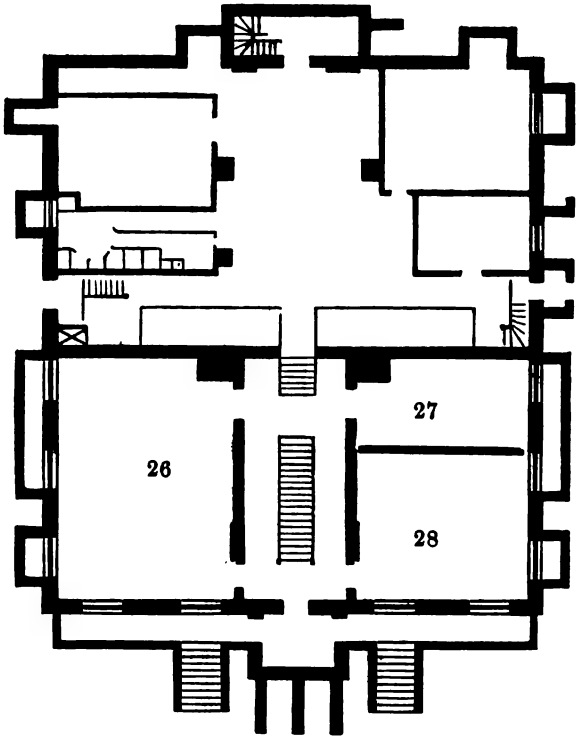
Under these four recitation-rooms in the basement of the building there are two large rooms and one small room completely finished. These rooms are all suitable for recitation-rooms, being well lighted and having a height in the clear of eleven feet.

The rear basement, under the general lecture-room, is occupied by a coal-room, heating furnaces and boilers, janitor's room, and water closets. The floor of this part of the basement is lower than the front part by four feet, to permit the floor of the lecture-room above to drop down from the front toward the speaker's table.

NORTH SHEFFIELD HALL.

PLAN OF THE BASEMENT.



No. 26. Recitation and Lecture-room.
27. Shop for Professor of Physics.
28. Recitation-room.

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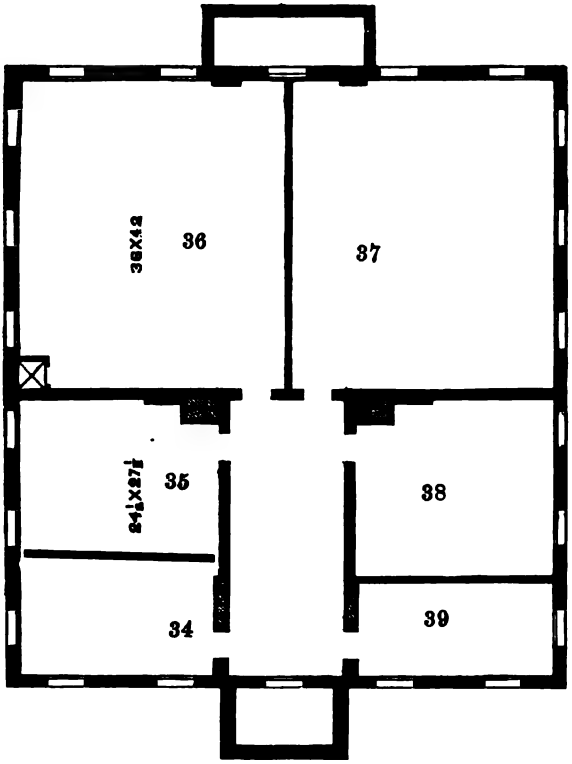
The second and third stories are divided alike,—two large rooms of equal size in each over the lecture-room, and four rooms on each story in the front of the building off the main halls.

The south side of the second story, consisting of three rooms, is devoted to Physics, the north, consisting of three rooms, to Civil Engineering. The small rooms in front are, for the present, appropriated to the Professors in those departments for study-rooms, the middle rooms for apparatus and recitation-rooms, and the rear and largest rooms for apparatus, lectures, and drawing-rooms.

NORTH SHEFFIELD HALL.

PLAN OF THE SECOND STORY.



No. 34. Private study, Prof. Norton.
35. Recitation-room, Civil Engineering.
36. Apparatus and Drawing-room, Civil Engineering.
37. Lecture-room, Physics.
38. Apparatus-room, Physics.
39. Private study, Prof. Lyman.

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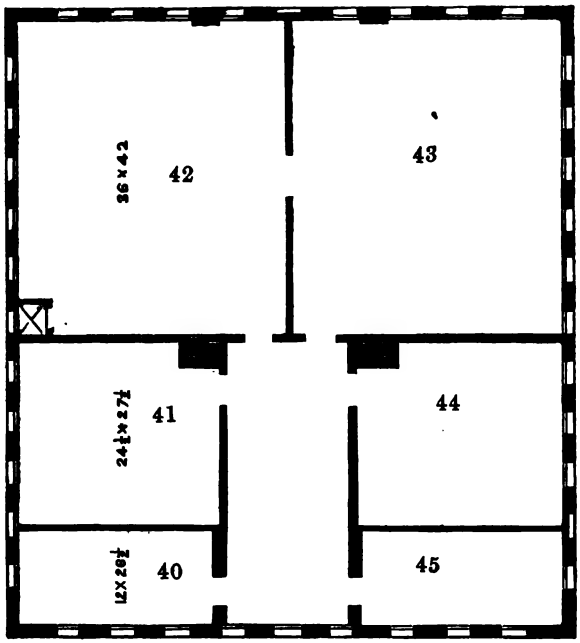
The third floor is arranged in a similar way. The south side is devoted to Dynamic Engineering, the large rear room on the north side to Natural History, the middle room to Botany, and the front to the purposes of a private study.

NORTH SHEFFIELD HALL.

PLAN OF THE THIRD STORY.



No. 40. Private study, Prof. Walker.
41. Botany, Prof. Eaton.
42. Natural History, Prof. Verrill.
43. Model and Drawing-room, Dynamic Engineering.
44. Recitation-room, Dynamic Engineering.
45. Private study, Prof. Trowbridge.

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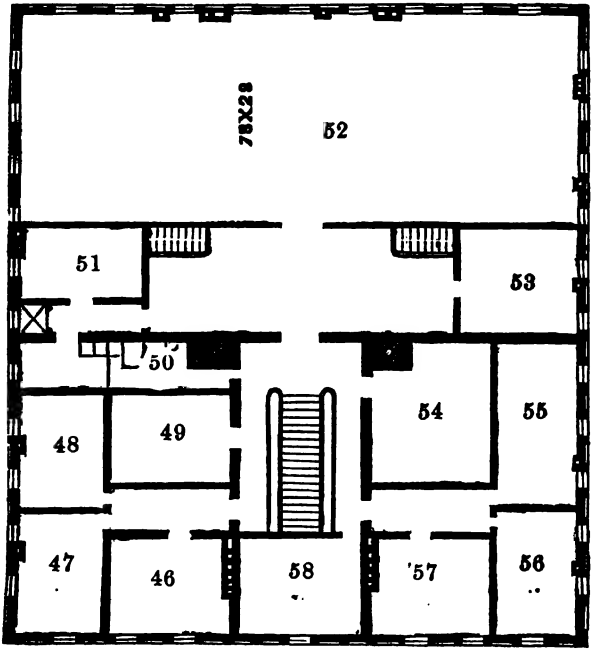
The fourth story furnishes one large room (73′×28′) for instruction in instrumental drawing, and eleven small rooms to be occupied as private rooms for instructors, and for store-rooms.

NORTH SHEFFIELD HALL.

PLAN OF THE FOURTH STORY.



No. 46. Private room for instructors.
47. Do. Do.
48. Do. Do.
49. Store-room.
50. Water closets.
51. Private room for instructors.
52. Drawing-room for Freshmen.
53. Private room.
54. Store-room.
55. Private room for instructors.
56. Do. Do.
57. Do. Do.
58. Do. Do.

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The interior finish of the building is plainly executed in yellow pine, coated with oil and shellac. The staircase and wainscoting of the halls are composed of pine, ash, and black walnut.

The building is heated and ventilated by the process and apparatus of Messrs. H. B. Smith & Co. of Westfield, Mass.

The boilers in the basement furnish steam which passes through pipes to steam chambers or "radiators" under the rooms to be heated; a current of cold air passing through conduits to the radiators is heated in its passage upward to the rooms by the steam-heated "radiators." To furnish places of exit for the heated air separate air conduits from all the rooms, provided with ventilators, pass up through the walls to the roof.

The larger lecture-room and all the recitation-rooms except two have ventilators opening into large conduits in the center of the building, which are kept heated by the smoke flues of the boilers, which are of cast-iron and pass up through the middle of these large conduits or ventilating shafts.

The building is thus not only thoroughly warmed but most efficiently ventilated. A trial of one winter of the apparatus of Smith & Co., arranged by their agent, Mr. Brownell, has fully confirmed the anticipations of the Trustees as to the efficacy of this mode of heating and ventilation.

As regards the carpentry and the mason work, the Trustees who have superintended the building operations not only wish to express their unqualified satisfaction with the manner in which it has been performed, but they feel that it is no more than simple justice to the respective contractors, Mr. Charles Thompson and Messrs. Perkins & Chatfield, as well as to H. B. Smith & Co., that public witness be borne to the integrity and ability with which they have carried out in every particular their contract. The plumbing work executed by Williams & Howland, and the gas work executed by Mr. Stratton of Derby, also give thorough satisfaction.

Before concluding, the Trustees likewise desire to say that too much praise cannot be awarded to the architect, Mr. J. C. Cady, of New York City, for the skill and success with which he has triumphed over difficulties of no ordinary character, in giving to the building an imposing architectural effect, without sacrificing in any way the convenience of the interior arrangement.

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Resignation of Professor Gilman.

The Governing Board regret to be under the necessity of chronicling the loss of one of their number, Professor Daniel C. Gilman, who has given up his position in this institution to accept the presidency of the State University of California. Professor Gilman was at a very early period interested in the Scientific School, and labored assiduously both in public and private to extend a knowledge of its operations and to promote its success. In 1862, while still holding the office of Librarian of Yale College, he first became connected with it as an instructor, and at the Commencement of 1863 was elected Professor of Physical Geography. Resigning in July, 1865, the office of Librarian, he from that time devoted his time and energies to the success of this department of Yale College, and was the principal exponent to the public of its work and progress. Yielding to repeated solicitations he accepted last year the presidency of the University of California, and departed to that State in October; and there his zeal, his ability, his untiring energy, and his fertility of resources have already begun to make themselves largely felt. None parted from him with more regret than those who had so long been associated with him in the management of the Scientific School; and they desire to express publicly here their appreciation of his earnest and constant efforts to promote the growth of this department, and their full confidence in and hope for his success in the new and broad field of labor upon which he has entered.

Addition to the Corps of Instructors.

The rapid growth in numbers of the School had been for some time forcing upon the attention of the Governing Board the necessity of increasing the teaching force in branches already embraced in the curriculum, and of providing instruction in some which had hitherto received little or no attention. The departure of Professor Gilman seemed, therefore, a suitable time to remodel to some extent the course of study, and to make some needed additions. Accordingly the instruction in Physical Geography was confided to Professor Brewer, it being a subject to which he had for a long time given special attention; and the chair of Political Economy and History was founded, to fill which an invitation was extended to General Francis A. Walker, then Commissioner of Indian Affairs. This action of the Governing Board was confirmed by the Corporation of Yale College at its meeting of December, 1872;

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the offer was accepted, and at the beginning of the second term General Walker entered upon the discharge of his duties. Professor Walker was graduated at Amherst College in 1860, and after a short time spent in the study of law, entered the army at the breaking out of the civil war in 1861. In this he remained until its close, occupying nearly all the time the position of Assistant Adjutant-General, and rising successively through the grades of Captain, Major and Lieutenant-Colonel, with brevet rank as Colonel and Brigadier-General for distinguished services. After the disbanding of the army he was engaged from 1865 to 1868 in teaching at Amherst College and at Williston Seminary, Easthampton, and in the last-named year became connected with the editorial staff of the Springfield *Republican*. In June, 1869, he was made deputy special commissioner of the revenue, having in charge the bureau of statistics, and in February, 1870, was appointed superintendent of the census. In this position he organized and conducted the ninth census of the United States. In November, 1871, he became Commissioner of Indian Affairs, and at the close of the last year resigned that position for the purpose of accepting the above-named professorship in the Scientific School.

Previous to this time the necessity of increasing the teaching force in the modern languages had become imperative; and during the middle of the last academic year the Governing Board were fortunate enough to secure the services of Professor Albert S. Wheeler, who assumed part of the instruction in the German language. With the beginning of this year the whole instruction in that department was placed in his charge. Mr. Wheeler had had much experience in teaching, having previously held the professorship of Greek in Hobart College, Geneva, N. Y., and of Latin and Greek in Cornell University. During the present year an additional instructor in French, Mr. Jules Luquiens, has likewise been added.

In pure Mathematics provision has also been made for a more thorough and extensive course by placing this department in charge of Mr. John E. Clark, who has successively held the Professorship of Mathematics in Michigan University, and in Antioch College, Ohio, but who at the time of his accepting the position was engaged in the survey by the United States Government of the North-western Boundary.

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Extension of the Course of Study.

At the request of the Governing Board, the Corporation of Yale College, at their meeting of March, 1873, created the degree of Dynamic Engineer, to be given to students who had successfully pursued the course of study of dynamic engineering for two years after their graduation as bachelors of philosophy. To correspond with this, the course of graduate study for the degree of Civil Engineer was extended from one to two years.

This extension had been for some time contemplated, as has also been the extension of the course of undergraduate study from three to four years. This last is a measure for which there is a great necessity, as some subjects of importance are, in the present limited time, unavoidably hurried over, or not studied at all. But the extension of the course to four years involves so large an outlay in the procurement of additional instructors and further accommodations, that the Governing Board have not yet felt warranted in committing themselves decisively to any definite action. It is somewhat disagreeable to be under the necessity of reminding the friends of the institution that the increasing number of students, while it is a source of great gratification and encouragement, is also attended with some disadvantages. The increase in the income caused by the admission of a larger number of students will never be sufficient to balance the expense of employing additional teachers for the purpose of furnishing them proper instruction. The best results of education can never be obtained where the divisions into which classes are arranged are large and cumbersome; and small divisions can only be secured by a corresponding increase in the teaching force. No institution, aiming to keep up the highest standard of instruction, can ever be self-supporting; and it is a fact somewhat unpleasant to contemplate, that the growth in numbers of a school, ordinarily the most conspicuous sign of its prosperity, must necessarily always have the tendency to cause some deterioration in the character of the instruction, unless assistance is obtained from sources outside of the income received from the students themselves.

National Aid to Schools of Science and Technology.

In the last annual report reference was made to the Congressional land grant of 1862, to the great benefits, outside of the direct pecuniary endowment, which this institution in common with many others had received from it, and to the possibility of an additional

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grant to the several institutions aided by the original act, a bill having then been introduced in the Senate with that object in view. Believing, as we do most firmly, that no small share of the proceeds of the public lands should be devoted to the purposes of higher education, we expressed then and there our confidence in the wisdom of the original enactment, and in spite of occasional failures, of its great benefit to the country generally, and especially called attention to the fact that it secured local responsibility under national aid; scientific education without any disparagement of literary culture; scientific schools rather than simple agricultural schools; and instruction funds instead of brick and mortar. During the last session of Congress, two different bills, making additional grants, passed the Senate and the House of Representatives by overwhelming majorities in each; but in the hurry which necessarily attends the closing hours of Congress, the measure failed for lack of agreement between the two houses as to details.

Lectures to Mechanics.

The annual course of lectures to mechanics, which have now for seven years been uninterruptedly given, was this year necessarily discontinued on account of the lack of room. The large hall of the Scientific School was, in consequence of the increased size of the classes, occupied during the winter term four hours every day, and no time could be found to make preparations in it for evening lectures. The hall in the new building will in the future obviate any such difficulty.

Additions to the Zoological Collections.

A. E. Verrill, Curator; S. I. Smith, Assistant.

During the past year the principal part of the special work in Zoölogy has been devoted to the marine animals of New England and adjacent waters. In this department our collection is now far in advance of that in any other museum. Most of this work during this, as well as last year, has been done in connection with the investigation of the fisheries, by Prof. S. F. Baird, U. S. Commissioner of Fish and Fisheries. During the summer vacation the Curator, with a party, including Mr. S. I. Smith, Mr. O. Harger, Mr. T. H. Prudden, and Mr. G. W. Hawes, assistants in this School; Prof. J. E. Todd, of Tabor, Iowa; Mr. J. B. Isham, and Mr. J. K. Thacher, of New Haven; Mr. J. H. Emerton, of Salem, Mass., and several others, joined Prof. Baird and his party at Eastport, Me.,

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and took charge of the investigations concerning the Invertebrate Animals of the Bay of Fundy, and made a very large and valuable collection. Of these a full series is to be permanently retained in our museum, while the duplicates are to be distributed to other institutions, after being carefully identified. Later in the season Messrs. Smith and Harger went to St. George's Banks on the U. S. Coast Survey Steamer Bache, and carried on dredging operations in that region. During this trip they dredged successfully at various depths down to 430 fathoms, which is the deepest dredging hitherto made on our coast, north of Florida. They succeeded in making a valuable collection, although the time available for dredging was short and the weather quite unfavorable. Later, Dr. A. S. Packard and Mr. Caleb Cooke, of Salem, Mass., made another trip on the same steamer and obtained many valuable additions to the Fauna of that region.

All these collections are at present in our laboratories, and have, as yet, been but partially studied. The general results of these explorations, together with descriptions of some of the new species, have been published, in part, by the Curator in the *American Journal of Science*. The results of the explorations of the St. George's Banks have been given in detail by Mr. S. I. Smith and Mr. Oscar Harger in a paper prepared for the *Transactions of the Connecticut Academy*.

The work upon the collections made in previous years on the southern coast of New England and the preparation of a report upon them have occupied much of the time both of the Curator and of Mr. S. I. Smith. Mr. Harger has also aided in this by elaborating the Isopods.

The detailed and illustrated report upon the marine Invertebrates of southern New England, for the U. S. Fish Commission, is now in press.

The osteological collection has also been greatly enriched during the past year, mainly through the very liberal donations made by Professor Marsh, who has not only purchased a large number of rare and valuable specimens, both mounted and unmounted, but has employed men to prepare a large number of skeletons from fresh specimens. Among the skeletons of special interest given by Professor Marsh is that of the East Indian two-horned black rhinoceros, accompanied by the mounted skin; the wombat; an ant-eater; the mountain tapir of South America, and the Mexican tapir.

Many valuable osteological specimens have also been presented by Mr. G. B. Grinnell (Yale, 1870), of New York.

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Rev. T. C. Trowbridge has forwarded the skeleton and skin of a camel from Turkey, together with other valuable specimens.

Mr. W. C. Coup presented an alligator, a boa, and the skeleton of a young African elephant, eight months old, of which the mounted skin was afterward obtained by purchase.

From Professor Baird we have received a collection of skins of sharks and rays taken in Vineyard Sound in 1871.

It is with great regret that we record the death of Capt. M. S. Porter, of New Britain, who was an excellent friend of our School, and who took great interest and pride in adding to our collections, whenever he had opportunities. He died very suddenly in Australia, last spring. From his father we have received a very beautiful and valuable collection of Australian birds, an ornithorhynchus, etc., which Capt. Porter had secured for our museum just before his death.

Capt. J. M. Dow presented an interesting collection of fishes, reptiles, crustacea, etc., from Central America.

From the Smithsonian Institution we have received a collection of seventeen bird-skeletons, collected in Alaska by Mr. H. W. Elliott, and a series of typical specimens of Muridæ, identified by Dr. Elliott Coues.

Numerous other donations have been received, which will be acknowledged elsewhere.

Additions to the Geological Collections.

O. C. MARSH, CURATOR.

Very considerable additions to the Geological Department of the Museum have been made during the past year, and a large proportion of these additions have been remains of fossil vertebrates, to which particular attention has been directed throughout. Unfortunately, for want of room, most of the recent acquisitions cannot be exhibited at present. In arranging and investigating the large acquisitions received by the Museum, valuable assistance has been rendered by Mr. Harger, Assistant in Palæontology.

Continued efforts have also been made by this department during the year to increase the collection in Osteology, more especially as an aid to the study of vertebrate remains. Several hundred skeletons of recent animals, most of them carefully identified, have been obtained during the year, so that ample facilities are now afforded for the study of Comparative Osteology. In increasing the collections in this department, important aid has been given by Mr. G. B. Grinnell, of the Class of 1870.

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The most important and valuable additions to the Geological collection during the past year have been obtained from the Cretaceous deposits of the West. A very valuable portion of them was obtained by a small party, which left New Haven, in October last, under the charge of the Curator, and spent about two months in Kansas, Colorado, and Wyoming, collecting fossil vertebrates.

Among the specimens from this region may be mentioned, perhaps the most interesting fossils yet obtained on this continent, the *Ichthyornidæ*, or the remarkable extinct birds with *teeth* and *biconcave vertebræ*, from the Cretaceous deposits of Western Kansas, a region already well known as abounding in fossil reptiles and fishes. Additional and very perfect remains of the large diving bird of the Cretaceous period (*Hesperornis regalis* Marsh) were obtained by the Yale party last autumn.

From the Tertiary deposits of Wyoming, many interesting fossils have been obtained, and among them are several specimens of the remarkable new group of mammals which have been named *Dinocerata* by the Curator. A description of these specimens, with figures of the most perfect skull, has been published in the *American Journal of Science* and in the *American Naturalist*. In the former Journal more than fifty new species of extinct American mammals, besides many reptiles and birds, have been described during the year by the Curator. The types of these species are now in the Museum, and naturalists will fully appreciate the increased value which has thus been conferred upon the specimens, many of which are unique.

A very considerable and expensive collection, mostly of foreign vertebrate fossils, has been obtained from Europe, and a large collection of bones of extinct birds from New Zealand. Other important additions have been received, which will be fully acknowledged elsewhere.

Additions to the Museum of Archæology.

The acquisitions in this department have been large and important during the past year, although no opportunity is yet afforded for making them available for study. The most valuable addition has been a large collection of Antiquities, mostly from Central America, which was made by M. de Zeltner, Consul of France, during his long residence at Panama. This collection contains probably the finest series of gold images and pottery from Chiriqui ever brought together, and is also especially rich in stone imple-

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ments. The entire collection was purchased in Paris by Professor Marsh, and presented to this department.

Another collection of much interest is a large series of native skulls from the Sandwich Islands, presented by Hon. J. S. Christie, Jr., vice-consul of the United States at Honolulu.

Large collections of stone implements, especially from the West, have also been received, and many other acquisitions of importance, which will be duly acknowledged in the list of donations.

Specimens intended for this department may be sent to Prof. O. C. Marsh.

Additions to the Mineralogical Collection.

G. J. Brush, Curator.

The duplicates of the collection of minerals have during the year been arranged by Mr. L. Stadtmueller, and many new specimens have been added to the general collection.

The most valuable acquisition made during the past year is a diamond crystal imbedded in its native rock from South Africa. This grand specimen is estimated to weigh sixteen carats, and was presented to the Scientific School by Chas. M. Wolcott, Esq., of Fishkill, New York.

Gifts to the Institution.

In addition to the sums subscribed for income mentioned in the last annual report, the School has received $1,000 for the general fund from Mr. John J. Crook of New York City.

A gift of $570 has also been received from the Class of 1871, through Mr. H. B. Sargent, the Class Treasurer.

Proposed Professors' Fund.

It has been previously announced that a friend of the School had offered to it $10,000, on condition that $50,000 be raised before the Commencement of 1873. Of this amount $26,000 have been subscribed, and $6,000 paid in. This leaves $24,000 still unprovided for.

The Library.

During the past year a number of accessions have been made to the Library, partly by gift and partly by purchase. Among the former are to be mentioned copies of Webster's and Worcester's Dictionaries, presented by their respective publishers; numerous publications of the Engineering Department of the United States

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Army; a complete set of the Patent Office Reports, section of Mechanics, by Professor Walker; and an elegantly illustrated Catalogue of the plated goods manufactured by Rogers, Smith & Co. To these and numerous smaller donations are to be added a collection of valuable scientific works and periodicals previously presented by the heirs of the late N. A. Bacon, Esq., but accidentally unacknowledged in the last Report. The additions by purchase have been few, the fund being in great measure exhausted by subscription to the current scientific periodicals, and by the necessity of putting the Library in thorough order. This latter has been going on steadily during the past year, a large number of volumes having been bound, and the work of making out a card catalogue having been undertaken.

Latin Entrance Examination.

No sooner had regular courses of study been organized in this institution than the deficiency of many students, otherwise well prepared, in a knowledge of common principles of grammar became painfully apparent. In consequence of this the teaching of German, of French, and of English was attended with special difficulties, and much delay was caused and the time of the better prepared scholars wasted by the constant necessity of instructing the less advanced students in the most elementary conceptions of grammatical analysis, and even of the meaning of the most elementary terms in grammatical nomenclature. As the classes increased in size this evil became a still greater source of trouble, and with the view of remedying it, the Governing Board, after full consideration, announced in the annual report for 1867–68 that after a certain period, as a condition precedent to entrance, a knowledge of Latin would be required sufficient to read and construe some classical author. No particular amount has ever been required in practice, it not being the intention to make the examination for the first few years at all rigorous. But even the result of this trial has fully satisfied the Governing Board of the wisdom of their course, and it is now believed by them that the time of experiment has fully passed. In the meanwhile, many letters have been received from all parts of the country in regard to the subject: some from applicants for admission wishing to be excused from this particular study, or desiring specific information as to the best manner of preparation and the length of time required; others from teachers asking for more precise and definite statements in regard to the nature and extent of the examination.

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With the idea of giving the fullest information to the public on all the points which had thus been brought before them, a series of questions, at the entrance of the last class, was addressed to each individual student as to the length of time he had spent in the preparation of Latin, and the extent of his reading, and a careful record was made of the proficiency of each applicant for admission, both as regards his knowledge of grammar and his facility in translating, with the idea of comparing it with his progress in the linguistic studies of the course. With this basis of facts collected the Governing Board, at the beginning of the academic year, appointed three of the instructors, Messrs. Wheeler, Whitney, and Lounsbury, a committee to report on the whole subject of Latin, so far as regards its connection with the education given in the Scientific School, and especially to take into consideration the various questions which had been raised by the inquiries of instructors and students. The report of the Committee was presented, through its chairman, Professor A. S. Wheeler, on Feb. 19, 1878, and after full discussion was adopted, as expressing the mature views of the Governing Board, and ordered to be printed in the annual report of the present year. The personal details upon which the conclusions are founded are, for obvious reasons, omitted; but the general conclusions which were drawn from an analysis of the facts presented are given in the following report.

Report of the Committee on the Latin Entrance Examination.

To the Governing Board of the Sheffield Scientific School,—

The Committee on the Latin Entrance Examination respectfully report:

In the absence of specific instructions the Committee have felt some perplexity in determining the precise range of topics which the report should cover, and have, therefore, felt obliged to follow their own judgments in regard to the fullness of treatment which should be given to various matters which have been brought to their notice. To those, consequently, who are unacquainted with the special circumstances that have taken place or the special inquiries that have been made, much included in the report may seem irrelevant or stated with too much detail.

The general plan of the report may be stated as follows:—The facts of the last entrance examination are first analyzed, compared, and commented upon, and the relation existing between them and

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the subsequent linguistic studies brought clearly into view; and in the second place, some suggestions, to which the consideration of the examination naturally leads, are then offered in regard to the proper quantity and kind of Latin reading, to methods of study, and to text-books. In this latter special efforts have been put forth to make as full and as satisfactory replies possible to the numerous inquiries on the topics under discussion which have been addressed to the Governing Board, both by instructors in the preparatory schools, and by students asking information for guidance in their studies.

(Here follows an extended statement of facts connected with the last Latin entrance examination. As it consists mainly of personal details, it is necessarily omitted.)

It is seen from the foregoing that among those who were regarded as well prepared, there were two marked and quite different kinds of preparation exhibited at the examination. These may profitably receive fuller and more careful consideration. They are representative of what, with some variation in degree and extent, may be expected in any similar examination, unless the requirements pronounce categorically in favor of one of them.

There is, first, what may properly be called a *grammatical* preparation, where there has been a small—perhaps very small—amount of Latin reading, but where the leading principles and terms of grammar have received careful attention, and where each sentence, or each word even, of the Latin read has been used for grammatical praxis, until by systematic reviewing the vocabulary and the most essential grammatical rules have been quite thoroughly mastered. It is not supposed that this study of the Latin Grammar is carried beyond what is necessary for the ready analysis of forms, and for the mastery of the leading rules of syntax. The grammar is studied as a preparation for intelligent reading, though but a small amount of reading is actually accomplished, and is not studied, as is sometimes the case, as though reading were done merely for the purpose of illustrating a grammar, and as though no useful reading were possible until every rule and every subdivision of it should have been memorized and repeatedly applied in parsing.

The second kind of preparation, for which it may be difficult to find an entirely suitable name, but which perhaps may suitably enough for present purposes be called *literary* preparation, differs from the former chiefly in extent of reading, and consequently in the acquisition of a far more extensive Latin vocabulary. It will

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be true no doubt that this further reading will tend to give a more absolute command over the grammatical forms and principles already studied than was possible to get from the reading of merely a few dozen pages of Latin authors, but it is assumed that the formal study of new topics in the grammar need not be carried to any great extent. Important deviations from rules already learned will of course be noted and remembered, and references to the grammar will be habitually made, but the chief reliance for advance in grammatical knowledge will be placed upon the student's own observation and induction; while the mastery of words and the study of the author's meaning will be held up as the great objects to which all others are to be subordinated. The student who has acquired this latter sort of preparation to the extent assumed by the report will be able to command a vocabulary of several thousand words, and be in a position either to prosecute Latin studies further with ease and advantage, or to take up other studies, for which a respectable amount of Latin is a valuable if not an indispensable preparation.

Of course, when these two kinds of preparation are contrasted, no one would hesitate in deciding which should be preferred. It is substantially a choice between more and less. Some would even maintain that the value of the knowledge gained in the former case would not repay for the time and labor consumed; that the study should either be carried further, or neglected altogether. But on the other hand, when one considers the deficiencies of the English grammars, and indeed the difficulty in making English the subject of grammatical analysis for those who use it as their mother tongue, unless the student is already trained in language; when one remembers the great excellence, for most purposes, of the Latin grammars, and of the whole body of classical text-book literature—the work of many generations of great scholars—as compared with the corresponding books that have as yet been prepared as hand-books for the study of any of the modern languages; that, surely, should not be regarded as useless knowledge, or as wasted labor, which does no more even than to give clear views of the elements of grammar and thus to make the study of English or of a foreign modern language easier and pleasanter than it could otherwise have been made. The very great value of this elementary knowledge of Latin, as a preparation for the course of study at the Scientific School, has been clearly illustrated during the present year. In but very few cases has a student, who was conditioned in Latin, done well in German. On the contrary, those

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who have experienced marked difficulty in learning accurately and satisfactorily what was required in German have in most cases been those who were unprepared in Latin. Facts and principles, which the other members of the class apprehended and learned with ease, have been to these a constant source of difficulty and perplexity. Not only have common rules and terms been habitually misapprehended, such as the agreement between an adjective and its noun, the difference between the dative and accusative cases, between the remote object and the direct object, but even the parts of speech and the simplest case-relations, things capable of being perfectly learned from the proper study of any tolerable English grammar, have been very frequently confounded. The term examinations in the modern languages gave a result in harmony with what has been stated of the recitations. It ought also to be added that the carefully proved facts of this year, both as regards recitations and examinations, do no more than confirm the impressions on these very points made upon the instructors in the modern languages during previous years.

In view of the facts thus presented the Committee have no hesitation in saying that the wisdom of the action of the Scientific School in requiring knowledge of Latin as a requisite for admission has been fully justified; that the students who come ill-prepared in Latin, unless of exceptional mental abilities, are placed at a great disadvantage in the study of modern languages as compared with those who have received a respectable training in that tongue; and that so far from lowering the standard of admission in this respect it should in time be made much higher, and a conformity to the present requirements should be rigidly enforced.

If the Latin preparation, even when only a minimum standard be enforced, be so manifestly and so immediately useful in pursuing the German course, where the historical connection between German and Latin is so slight and remote, it could hardly fail to tell with increased importance upon a course of French study. Here, indeed, a preparation in Latin would seem quite indispensable, especially if there were any attempt to pursue the study of French historically, and to read the earlier French authors.

It may be said, further, in showing something of the utility of the short but definite and thorough course which the so-called grammatical preparation requires, that this is amply sufficient to enable a scientific student to master readily the derivation and signification of all scientific terms of Latin origin, to read, with the aid of a dictionary, such scientific Latin as he should wish, and

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to study, with ease, any of those languages which, like the French, are descended from the ancient Latin. Much that might be added in this place is omitted, as it seems to be rather a discussion of the general utility of Latin, which the Scientific School has by its requirements assumed. All that is designed here is to show the unmistakable value of even the limited but definite Latin preparation, which has been described above, in case the requirement of a higher standard of preparation should be thought unadvisable. It may be stated here, as it was not expressly stated above, that this so-called grammatical preparation is not and cannot be attained by mere study of grammar, nor should he be regarded as having attained it, who has not taken the trouble to remember his vocabulary such as it is, no matter what skill he might show in the manipulation of it. Young students are apt to fancy that the knowledge of a grammar and the knowledge of a language are identical, and frequently do not conceive of the practicability of acquiring such a vocabulary as to render a dictionary in a measure unnecessary, or to reduce to the minimum the necessity of referring to it.

The Committee have given some reflection and made some inquiry from experienced teachers upon the question how much time is required for such preparation as the examination disclosed, as well as for such preparation as the report has considered. It seems to be clear that in one year of efficient instruction and of reasonably diligent study a student should acquire an adequate amount of grammatical knowledge and read carefully at the very least three books of Cæsar, or something else equivalent to it, while if the student be not quite young, there is no reason why from four to six books may not be accomplished. At any rate it may be regarded as settled that to secure the first kind of preparation recognized above, and to read besides—not to name a definite amount—considerably more than is there assumed as necessary may easily be done in one year, unless there is some great inefficiency in the instruction, or some absurd method followed, or an uncommon want of diligence or capacity on the part of the student.

It is more difficult to say how much time is necessary to attain the second standard of preparation that has been mentioned, inasmuch as the amount and kind of reading may vary materially; but there can be little risk in the statement that after the first year's study, which would involve the reading of from three to six books of Cæsar, or what is equivalent to it, a student should read

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in the next year or eighteen months what would constitute very liberal preparation.

It will be seen that the opinions herein expressed as to the time necessary for certain reading are not fully supported by the statistics of the examination. These statistics do, indeed, show that the lower kind of preparation we have described should not consume more than a year at the utmost, and that several of the students who had come up to this standard had studied, apparently without any pressure, not more than a year and in some instances less.

Which kind of preparation should be exacted from applicants for admission to the Scientific School is a question which is probably not included in the subjects referred to the Committee, and the report will therefore go no further than to point out the two above-described kinds of Latin preparation, and the time necessary for each. It may be well to add that the preparation necessary for admission to the Academic Department corresponds pretty closely with the second kind of preparation contemplated above. Though it is believed that a course of reading might easily be selected far better adapted to the future needs of the scientific student than the course usually required for admission to classical colleges, yet, at present, there would be such difficulties encountered in respect to text-books and instruction as renders the recommendation of such a special course unadvisable. Most of the Latin teaching in schools is arranged with reference to the needs of those who are preparing for a course of classical study. Although the authors read, the mode of reading them, and many other things could advantageously be changed in the case of those intending to pursue scientific studies, and who are not aiming at a knowledge of Roman history, literature and antiquities, yet it is doubtful whether a plan better upon the whole could at present be adopted, than, if the standard of preparation in Latin is to be materially raised, to require from all applicants nearly the same Latin preparation as is necessary for admission to the Academic Department. By substituting some equivalents in the reading required, yet not sufficient to interfere materially with the curriculum of the schools, some work could be escaped which for the scientific student would be either wholly useless, or not worth the time it would require.

It is perhaps best to add one statement, however, for the benefit of those who are preparing students for entrance to this institution, and who have asked that more definite information should be given of the precise nature of the requirements here demanded.

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The Sheffield Scientific School in requiring Latin had a purpose of its own, and one entirely distinct from that aimed at in classical colleges. It was not that its students should be acquainted with the language and literature of that tongue, but that they should come prepared with a knowledge of those general principles of grammar, which are as essential to the proper study and thorough comprehension of German, French or English as of Latin, and which can be best learned through the medium of the last-named language. Anything which does not lead to that result, however good it may be in itself, is not essential to the end had in view. Hence Latin prosody, or Roman history and antiquities, beyond what is necessary to a comprehension of the author read, would necessarily form here no part of an examination. But the general statement being given that Latin is required for the knowledge it furnishes of the common facts and general principles of grammar, it is felt that all application of it may be safely left to the good sense of instructors themselves.

It may be well to consider briefly the subject of the kind of reading most useful for those who aim merely at some knowledge of the Latin language, separated so far as may be from all that is local and historical. Some ancient authors are much farther removed from us than others. Their works are filled with words and phrases, to understand which an industrious collateral study of history, archæology, mythology and similar subjects is indispensable. Others seem almost like moderns, and though they use the Latin language, they express thoughts or describe events or things that are intelligible at once—almost as much so as much of the modern Latin, which has often been the medium of communication between modern scholars. One ought in the study of Latin, as of other languages, to select his reading with reference to the vocabulary that he wishes to acquire, and it is assumed that the scientific student does not wish to spend much time in the study of words representing notions or institutions purely historical. For example, how easy it is to learn that *equus* means horse, and that *aurum* means gold, and how hard it is, and for the general student how unnecessary, to learn what is meant by *judex*, *comitia*, and thousands of other words, that suggest historical facts or local institutions, for which modern life and society have no exact counterpart. Hence, poets who constantly use either rare words or common words in peculiar metaphorical senses, or historians and orators whose subject-matter usually necessitates the study of historical events, political institutions, legal processes and defini-

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tions, and many other matters purely Roman, would manifestly not be so suitable reading as authors who use largely common words representing conceptions which form the basis of all cultivated languages, and who use them in their radical significations. If, then, a student is aiming not at a general and comprehensive Latin scholarship, his reading should take such a direction as his special objects make most expedient. The student of Roman law would adopt one course; the student of medicine quite another. This remark does not apply to the very early stages of Latin study, as there is a body of common words and phrases and of grammatical usages which are needful for reading anything: only in acquiring these, such authors should be read as present them freest from union with anything non-essential. Hence, Cæsar is, on the whole, a better introductory author than Virgil or Cicero. His vocabulary is simpler and of more general applicability. Many of his words are the names of material things or of simple and easily intelligible notions, and are hence far easier to acquire than words which have been subjected to a variety of metaphorical and rhetorical changes; the nature of his subject makes abstract discussion and therefore the abstract significations of words, and the more difficult grammatical constructions, somewhat though by no means wholly unnecessary, while the style of the author is such as usually to present a difficulty in the most intelligible form possible. Still, Cæsar presents some unquestionable and special difficulties; while the Commentaries, regarded as a whole, do not contain such a variety of words and usages as might easily be found in the same quantity of Latin. Indeed, if the speeches which are interspersed throughout his narrative be considered, or if the work be made, as some teachers make it, the means of teaching what they know—or think they know—of the subjunctive mode, or the whole doctrine of the Oratio Obliqua, Cæsar will be found to present many difficulties that would seldom be encountered in either Virgil or Cicero. These difficulties would be considerably increased if the book were read, as is advantageously enough done by the advanced or the special student, with minute attention to military operations and to the geography and ethnography of ancient Gaul. Still, these possible difficulties may be fairly passed over by the young student, and his attention may be directed to such subjects as Cæsar's narrative style is admirably adapted to teach. If these other matters should become necessary to be attended to, the book may be re-read, with this object, at a later stage of Latin study.

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But the Committee would not be understood as recommending that an acquaintance with any particular author shall be insisted upon as a condition precedent to entrance; any equivalent amount of any classical writer should, in their opinion, be always accepted as a substitute. For the benefit of those more especially who are carrying on their preparation in this study by themselves, they may be pardoned for suggesting Allen's Latin Reader as furnishing possibly a more desirable course of reading than Cæsar's Commentaries. Embracing a wide variety of selections from classic writers, and containing a large vocabulary, this work is excellently adapted for the use of those who wish a general acquaintance with Latin, but have not the time nor the inclination to pursue the subject far enough to read entire authors. Such a book, thoroughly mastered by repeated readings, would secure a very respectable knowledge of Latin, and one far more useful than is often acquired by a more showy and pretentious course of study. The work has also the additional advantage of being one of a series of Latin text-books, which refer to and illustrate each other. Of one of these,—Allen & Greenough's Latin Grammar,—both on account of its comparative brevity, and from the fact of its embodying some of the most important recent results of the science of language, the Committee feel no hesitation in recommending the use to students in preparing for the Scientific School. This book, indeed, aims to do for Latin scholarship what was so admirably done for Greek by the grammar of Professor Hadley. There are in the possession of the public many valuable Latin grammars, some of which, to be sure, are more particularly designed for advanced students; and it may seem invidious, in consequence, to recommend one book or one set of books in preference to others. Still if one work is, on the whole, superior to others for our specific purposes, and especially if it represents an advancing movement of scholarship and science, it seems advisable to declare distinctly in its favor.

In every branch of classical study there still linger on the stage many old-fashioned and worse than useless books, whose occupation has long been gone, but of which owners of copyrights and publishers are interested in securing the sale. In some localities, Bullions' Greek Grammar is actually preferred to the Grammar of Professor Hadley. And when one really considers the question, is there anything more invidious in the preference of one or of a set of preparatory text-books, than in the choice of one or of a set of books in the collegiate course? Indeed, the injury done in

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schools by inferior text-books is greater by far than is possible in the more advanced institutions, as in the latter case the teacher will usually be able to correct the grosser errors of the text-book, and to neutralize, by his own supplementary instruction, its defects and its errors.

A well-made exercise book for practice in the translation of simple sentences from English into Latin, to illustrate the grammar, is one of the Latin series referred to, and the Committee would recommend, in case the suggestion in regard to Latin Grammars be accepted, that this book or a similar one be required also. An acquaintance with it is a guaranty of mastery of forms and rules such as mere translation of Latin into English does not furnish, while the study of it makes such translation easier and more interesting.

There is less objection, in the opinion of the Committee, to the specific recommendation of books and of methods of study, as so much of the Latin teaching in schools is done by comparatively untrained linguists and inexperienced teachers. In the large majority of cases it is believed these are young graduates of college, who for ulterior objects spend two, three, and four years in teaching, and who are usually so pressed with work that they cannot if they would make up to any considerable extent their own deficiencies. The consequence frequently is that the student is put over precisely the same course, good or bad, that his teacher had pursued, and thus many defective and even pernicious methods have been perpetuated by a long succession of *pro tempore* teachers, and the student's time and the cause of classical education have often been sacrificed. Even among unquestionably competent Latin scholars, tradition and fashion have often had undue influence, and their own narrow-mindedness has sometimes been one cause of the failure, partial or complete, of classical studies to secure a really good education. Methods and objects, proper and useful enough in the sixteenth century, have been held on to in some places with almost religious bigotry; reasons for classical study, which in fact are chiefly historical, have been invented, of a necessary and *à priori* character; and the growth of modern literatures, the advance of science, and in particular of the science of language, have often failed to open the eyes of the classical zealot to the changed position of classical studies in the sum total of human knowledge.

It is probably a legitimate subject for the report, as throwing light upon the low grade of preparation exhibited at the examin-

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ation in proportion to the time of study, to consider some of the grosser abuses which have made and still make Latin studies so unfruitful as to awaken in many minds grave doubts whether they possess any utility whatever, and while stating the abuses, to point out some intrinsic difficulties which are frequently overlooked when this subject is discussed by educational theorists and would-be reformers.

Among the foremost causes of very limited reading, and consequently deficient scholarship, must be reckoned the abuse of grammar. Students have often been compelled, even in schools of the highest reputation, to spend months and years in memorizing and reviewing the Latin Grammar, and to give such an excessive amount of time to merely grammatical praxis that the amount of reading done is quite insignificant, and in fact contemptible. The proper objects for which modern languages, and indeed most ancient languages are studied, are ignored, and it would actually seem as though no more Latin was designed to be read than was necessary to illustrate the sections, and the subsections, and the sub-subsections of some favorite grammar. So much has this been the case that many a student who has spent years upon Latin is yet unacquainted with the contents of one single ancient author, and from the neglect to aim at the acquisition of a vocabulary, is unable to read a passage of new Latin without the laborious use of a dictionary. As rather a striking illustration of the cruel absurdity which has sometimes characterized Latin teaching in the particular now under consideration, may be mentioned the testimony of a prominent chemist, in another institution, who once informed a member of the Committee that though when a boy he had studied Latin at one of the leading preparatory schools of the country, he was so entirely ignorant of the language that he could remember nothing but a portion of a long list of exceptions to one of the rules of prosody. He had studied Latin for a year, had memorized with little or no reading the bulk of Andrews & Stoddard's Latin Grammar, and all he could remember was a portion of Exception 2d, Subdivision 22 of Section 229, to the effect that *barbarus* and thirty-one other words do not make their penults long before *-rus*, *-ra* or *-rum*. It should be added that of these thirty-two words, none are defined in the grammar, and ten of them are of such infrequent occurrence that many an excellent Latin scholar would need to look them up in his dictionary if he should meet them in his reading. That the failure in this case to learn more Latin was due to any natural

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deficiencies in the boy himself is sufficiently refuted by the fact that he has become a proficient in at least two modern languages, and has read freely in their literatures; but the early disgust he had conceived for Latin had prevented his ever resuming the study of this language, though he often felt the need of some acquaintance with it. Other significant illustrations might be given. Especially has the study of the syntax of the subjunctive mood in Latin, and of the case-system in Greek, consumed time and attention that could have been far better employed. Even if the theories, assumed by grammarians, of the origin of verbal and case forms had been correct, it was a faulty method of teaching language to require regularly the analysis of the supposed conception in a writer's mind which led to the employment of them. Formal analysis and conscious mental action are probably far less efficient in the study of language—certainly with young students —than imitation and unconscious induction. But, in fact, the science of language has shown that very much on which the last generation of classical students have been laboriously drilled is mere rubbish.

It cannot be denied, indeed, that a certain kind of training is secured by this pernicious and wasteful method, and this training, it is believed, is what may fairly be supposed to be meant when the preëminent value of Latin study as a means of mental discipline is asserted. No doubt, the careful study of the grammar of any language trains and develops some of the faculties of the mind, especially the power of subtle discrimination and readiness in the application of general rules; yet such training can be just as effectually secured when this end is subordinated to the learning of the language, so far as is necessary for at least the mastery of the contents, the style, and the individuality of certain leading authors, and when the discipline is allowed to come of itself, as an incidental though inevitable consequence upon thorough study. A practical reaction against excessive grammatical study, as has been mentioned above, has taken place of late among classical scholars themselves, and it is probable that more correct and rational methods are likely to be followed.

This abuse of grammar has been due, in part, it is believed, to the fact, that many of those engaged in classical teaching have found it an easier and pleasanter subject for themselves than to aim at the reading and illustration of authors. An intelligent person of adult years, though not familiar to any considerable extent with Roman authors, or Roman history and antiquities,

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with far less and a different kind of labor than the acquisition of such knowledge requires, may become an acute grammarian, and will be quite likely to direct the attention of his pupils to this subject as it is most familiar and congenial to himself. The boy, therefore, whose active memory could rapidly acquire a large vocabulary, but whose mental immaturity disqualifies him in a measure for the logical distinctions of higher syntax, makes imperfect progress in his studies, and perhaps abandons them at last in disgust, and denounces them as useless.

Another circumstance, somewhat connected with the foregoing, has often led to failure or to quite inadequate results in classical studies. It is often supposed that to become a good classical scholar, one should begin these studies very early. There is reason to believe that this is a grave error, and that much time is lost by it. A course of Latin study, it is true, could be made suitable for a very early age, and in those days when facility in speaking and writing Latin, as well as reading it, was a prominent object, the study almost necessarily began early. But a complete change of conditions would suggest a complete change of methods. When, indeed, it is considered how much there is of difficulty in the mass of Latin authors; the great elaboration and brevity of their style; the capacity of the language for involved and intricate construction, which literary fashion encouraged, and sometimes exaggerated; and add to all this the difficulty arising from subject-matter wholly strange to a modern reader—strange in theology, in philosophy, in law, and in fact in everything representative of the civilization of the people: it does seem that it would be judicious to allow a boy to attain some considerable mental maturity, to awaken his literary sense by some acquaintance with his own literature, and to train his linguistic faculties by the study of his own on some other modern language, before requiring him to face a combination of difficulties so formidable. It is believed that it would be far more economical of time, and in every way more advantageous, if the reading of Latin authors was postponed a few years later than is now the custom. Of course, if one should wish, the elements of the Latin Grammar, the inflections and the principal rules of syntax, could be learned early, and simple authors could be read. The position of the Report is merely that the representative Roman authors, from which any extensive knowledge of Latin is to be derived, and any correct conception of Roman literature obtained, should come considerably later than is now the case. Professor Madvig, in the preface to his Latin Grammar, expresses

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the opinion that in Europe time is lost from beginning Latin study too early, though the period he suggested for beginning it is earlier than that contemplated in the report.

The wide incompetence of classical teachers is another cause,—temporary probably, but very much to be regretted,—of unsuccessful classical study. Only those, perhaps, who have had considerable experience in conducting college entrance examinations can realize this in its full extent; but the knowledge of the fact is by no means confined to them. Able and experienced scholars who are at the head of various preparatory schools scattered throughout the land, find this one of the most formidable difficulties they are obliged to encounter in giving efficiency to the institutions under their charge. Of course this state of things cannot be so noticeable in New England as in other parts of the country. Aside from the fact, intimated above, that so many classical teachers are young college graduates, there are many academies, select schools and public schools in which the bulk of the higher teaching is done by one man. He does this, perhaps, year after year, beginning probably with only general attainments, which subsequent reading does little to advance. It cannot be expected that much efficient teaching of any kind can be done under such circumstances, still less in a language so difficult as the Latin, and where such wide and varied reading are necessary for the elucidation and illustration of a single author.

The extremely critical character of much of the classical study, and the consequent neglect to encourage and form the habit of cursive reading, as it has been called—rapid, and intelligent, but necessarily uncritical reading—leads many to suppose that ancient authors can be profitably read only with the utmost labor, and with constant employment of all critical apparatus. Such a severe standard of thoroughness is held up as renders any wide reading impossible, unless it be the sole work of a life-time. If one were to read his native English authors with the same degree of minute attention as is sometimes given to every sentence or word of Homer or Virgil, far fewer than now would ever get through "Paradise Lost," as but few American students ever do read the entire Iliad or the Æneid; Shakspere could only be read (as the Greek and Roman drama usually is) in specimen plays, and any liberal knowledge of English literature would become confined to professional English scholars alone. This cursive reading, though difficult, would be quite practicable, even in a preparatory course. The student might at least attain a conception of the nature and

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utility of it, and at a more advanced stage of study he could profitably follow it either in the class-room or in his private reading; whereas now, the private study of ancient authors, from the supposed necessity of very critical reading, is seldom practiced, even by the most diligent and ambitious students.

The wide diffusion, too, of very literal English translations of those ancient authors most commonly read has been a powerful cause of imperfect scholarship; but as it may be supposed that this operates to a very limited extent in the early stages of study, it is enough in this place to make only allusion to it. In teaching many authors, the consciousness that a large portion of every class make more or less use of these translations,—which not infrequently are inaccurate and almost always inadequate,—causes the instructor great perplexity. It becomes a work of greatly increased difficulty to develop a power of original and independent analysis, on which any real mastery and appreciation of the author studied depend. Of course, the coöperation of two or more of the causes that have been enumerated, is to be expected, and rarely is one found to exist alone. It is easy to see that their combined influence will explain much of the ignorance that prevails among Latin students, even after years of study. And it is probable that many a classically trained student, in taking up the study of modern languages, has lost time and courage while attempting to follow some method of study he had derived from his experience in the ancient languages.

One further statement is necessary, of a circumstance often overlooked. The great increase within half a century in the number of subjects of educational value has led to the custom of engrafting on the old curriculum a large number of new studies. This has so reduced the time allotted to the classics that it is impracticable to attain those beneficial results which they are fitted to produce. This new composite course of study, in which the classics occupy considerably less than half the time, sometimes less than *one-third* of the time, is still called "The Classical Course," though the Classics have been virtually displaced. The student perhaps learns how to read Greek and Latin, and is then set at some new subject, leaving the authors for the reading of which so laborious and long a preparation has been made quite unread. The study is abandoned at the very point when its utility and disciplinary value would be most manifest. Of course such a procedure would discredit any branch of study.

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It may be further added, in conclusion of this part of the subject under consideration, that no curriculum can probably ever be devised that shall secure wholly satisfactory results. The failure of one course of study with one individual or many proves nothing till it be clear that these persons were capable, as very many notoriously are not, of the continuous and cumulative study which is necessary for proficiency in any subject whatever. Even in England, where fashion has kept up a devotion to classical studies not common elsewhere, and where pecuniary and other powerful inducements to pursue them exist, it is stated, by a distinguished English classical scholar, that the majority of students do not acquire any thorough knowledge of the subject, and seldom rise to the point of critical literary appreciation of ancient authors. But it does not follow that this failure is due to the nature of the subjects studied. It may fairly be attributed in part to imperfect methods, in part to the fact that mental capacity is the exception and not the rule.

The Committee, in concluding their report, cannot refrain from expressing the conviction that the rigorous exaction of a fair knowledge of Latin, as a condition precedent to admission into the Scientific School, will not only be of great advantage in the student's subsequent studies, but will benefit the cause of general education, and will be hailed with satisfaction, as well by teachers of Latin as by all who are opposed to lowering the standard of acquirement in courses of educational study leading to a degree, and to the dissemination of false notions among the uneducated classes. In many parts of the country, in consequence of the imperfect results of classical study, as it has too frequently been conducted, there has arisen a sentiment utterly hostile to such study; and men of station and of influence, sometimes from mistaken convictions, and sometimes, it must be believed, from a spirit of educational demagogism, have decried Latin and Greek as useful for no purpose whatever. This might have been more harmless, if some substitute for them had been offered, equally exacting and disciplinary: but in most cases no such substitute has been presented; and so these leveling and iconoclastic movements have availed chiefly to narrow the range of thought and knowledge of the student, to encourage that natural indolence and incuriosity which often leads a young man to "elect" one course in preference to another merely because it is reputed to be easier, to foster ignorance and sciolism, and to spread false and pernicious doctrines in regard to the true nature and objects of education. Doubtless, there is no magic in Latin, and

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few purely educational advantages can be claimed for it that could not be claimed for several other languages and literatures, ancient and modern; but considered merely as an instrument of investigation, wholly indispensable to some classes of students, and serviceable to many if not to all classes, it must be allowed to possess an unquestioned utility, and to have a practical value, even in the lowest sense of these greatly abused words. The kind of knowledge and the extent of it needed, as is the case with every other subject, will of course vary with the special views and the tastes of individuals, as has been already indicated above.

Great ignorance and misconception in regard to the whole subject of literary and linguistic studies prevail in the minds of many persons, who are not, however, backward in expressing dogmatic views in regard to them. It is, in consequence, all the more essential that the Scientific School should do all that lies in its power, and exert any influence it may have, however slight, toward the spreading in the community of rational and philosophical views on the subject of education. The petty and prejudiced spirit which has at times been manifested by classical zealots toward science should never be allowed to find a counterpart in the attitude of men of science toward literary and linguistic study; yet this must inevitably be the case if the broad general principles which lie at the basis of all education are not fully recognized and acted upon in the institutions of which they have the control. It does not follow because new branches of learning of great interest and value have been developed, that the study of what in the past has been held useful must be abandoned. That education, whether it be classical or scientific, which so narrows for any man the field of vision that he can see little merit or utility in branches outside of his own department, must be looked upon as a failure. There is no saving virtue in any course of study or any kind of knowledge. The denial of the benefits of classical study on the part of scientific men would be as great a blunder, as has been the denial of the value of scientific study by devotees of the classics. All knowledge has claims upon us, and the cause of education in general suffers when any branch of learning is disparaged or misrepresented. It is gratifying to be able to believe that the Scientific School, by requiring some knowledge of Latin as a requisite for admission, though doing so for its own purposes and its own advantage, is yet sustaining the cause of sound education, and contributing in no slight degree to the broader intellectual development of those whose instruction has been intrusted to

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its charge, by placing them in a measure in sympathetic and intelligent relations to other leading departments of knowledge, in which few of them can ever hope to make any extensive acquisitions.

In conclusion, the Committee would make to the Governing Board the two following specific recommendations:

1st. That six books of Cæsar's Commentaries, or an equivalent amount in some other author or authors, be hereafter regarded as the minimum amount which will be accepted in the Latin examination, and that this requirement be rigidly enforced.

2nd. That after the Examination of 1873, an examination be also required in some text-book for the translation of simple exercises from Latin into English.

All of which is respectfully submitted,

A. S. WHEELER,
W. D. WHITNEY,
T. R. LOUNSBURY.

Anniversary.

The anniversary exercises were held in Sheffield Hall, on the evening of Monday, July 8, 1872. Eight theses were selected for public reading.

The candidates for degrees, with the subject of their theses, are given in the following schedule. Those marked with an asterisk were read in the evening.

CANDIDATES FOR DEGREES.

WITH THE SUBJECTS OF THEIR GRADUATION THESES.

CIVIL ENGINEERS. (2)

HORACE ANDREWS, Ph.B., *Tarrytown, N. Y.* Design of a Parabolic Roof Truss.

MANSFIELD MERRIMAN, Ph.B., *Plantsville.* Design for a Railway Draw-bridge.

BACHELORS OF PHILOSOPHY. (22)

*JACOB JACKSON ABBOTT (Select), *Yarmouth, Me.* On Man in Pre-Historic Times.

JAMES PETER BOGART (Engineering), *New Haven.* On the New Haven Sewage Plan.

*WHEELER DEFOREST EDWARDS, B.A., College of City of N. Y. (Engineering), *New York City.* On the East River Bridge.

JOSEPH RIDGWAY GAWTHROP (Engineering), *Northbrook, Pa.* On the New York and New Haven Railway Bridge over the Housatonic.

WILLIAM SAUNDERS GREEN (Chemistry), *Cincinnati, O.* On the Production of Boiler-Plate Iron from the Bloom Forge Iron Works, at Portsmouth, O.

GEORGE WESSON HAWES (Chemistry), *Boston, Mass.* On Education for Mercantile Life.

*DANIEL WEBSTER HERING (Engineering), *Johnsville, Md.* On Water-Pressure Engines.

*CHARLES LOUIS JOHNSON (Select), *Ansonia.* On the Monosyllabism of the English Language.

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CASSIUS WILLIAM KELLY, B.A, Yale College (Engineering), *Erie, Pa.* On the Problem of the Rafters.

*SAMUEL TREVOR KNAPP (Select), *New York City.* On the Land Tenure and other Institutions of the Dutch upon the Hudson River.

HARRISON WHEELER LINDSLEY (Engineering), *New Haven.* Review of an Iron Bowstring Girder Bridge near New Haven.

*FRANK OSCAR MAXSON (Engineering), *Norwich.* On Pneumatic Caissons.

ROBERT DOUGLAS MILHOLLAND MAXWELL (Select), *Wilmington, Del.* A Cartographic Study of the Peninsula between Delaware and Chesapeake Bays.

GEORGE NOYES MILLER (Select), *Wallingford.* An Investigation, partly from Original Sources, as to whether Eleazar Williams was a Bourbon.

THOMAS PERKINS NEVINS (Engineering), *Waterford.* A Partial Examination of the Works of the New Haven Water Company.

*THEOPHIL MITCHELL PRUDDEN (Medical), *New Haven.* On the Anatomy and Habits of the Larger Fiddler Crab (*Gelasimus Minax*).

THOMAS HUBBARD RUSSELL (Medical), *New Haven.* On the Anatomy of the American Lobster.

CHARLES AUSTIN TIBBALS (Select), *Brooklyn, N. Y.* On the Rise of the British Drama.

DANIEL WARDWELL WARDWELL (Select), *Rome, N. Y.* On the Text of Chaucer.

*FREDERICK FLOYD WELD (Engineering), *Guilford.* On the Burleigh Air-Compressor and Rock-Drill.

WILLIAM BRENTON WELLING (Select), *New York City.* On the Influence of Monasticism upon Education in England.

THOMAS WALLACE WRIGHT, B.A., Univ. of Toronto (Engineering), *Galt, Canada.* An Investigation of New Formulæ for Finding the Strains in Continuous Girders uniformly Loaded.

Prizes.

The following prizes were announced at the anniversary.

The value of each of these is $10.

CLASS OF 1872

For excellence in Mineralogy, the prize awarded to GEORGE W. HAWES, *Boston, Mass.*

For the best collection of the Compositæ described in Gray's Manual of Botany, the prize awarded to THEOPHIL M. PRUDDEN, *New Haven.*

For the best collection illustrating the fresh-water Zoology of New Haven and vicinity, the prize divided between THEOPHIL M. PRUDDEN, *New Haven*, and THOMAS H. RUSSELL, *New Haven*, equal in rank.

For excellence in French, the prize awarded to FRANK O. MAXSON, *Norwich.*

For excellence in Civil Engineering, the prize awarded to FRANK O. MAXSON, *Norwich*, with honorable mention of DANIEL W. HERING, *Johnsville, Md.*

CLASS OF 1873.

For excellence in the Mathematics of Junior Year, two prizes awarded, one to WILLIAM A. JENKS, *Brookville, Pa.*, and one to WILLIAM L. SCAIFE, *Pittsburgh, Pa.*

CLASS OF 1874.

For excellence in all the Studies of Freshman Year, the prize divided between ALLEN B. HOWE, *Troy, N. Y.*, and HENRY HUN, *Albany, N. Y.*

For excellence in German, the prize awarded to ALLEN B. HOWE, *Troy, N. Y.*

For excellence in Mathematics, the prize awarded to IRVING L. HOLT, *Meriden.*

For excellence in Physics, the prize awarded to HENRY HUN, *Albany, N. Y.*

For excellence in Binn's Orthographic Projection, the Prize awarded to CHARLES J. MORSE, *Poland, O.*

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PROGRAMME OF STUDIES,

AND

CATALOGUE,

For the College Year 1872–1873.

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Charles Benjamin Dudley, B.A.	*New Haven,*	460 Chapel st.
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William Righter Comings,	*New Britain,*	177 Temple st.
William Allen Cowles,	*New Haven,*	19 Park st.
Charles Adams Cragin,	*Wallingford,*	169 Temple st.
Robert John Currey,	*San Francisco, Cal.*	122 College st.
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William Lucien Scaife,	*Pittsburgh, Pa.*	8 Lock st.
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Arthur Bucklin Claflin,	*Boston, Mass.*	159 Temple st.
Frederick Bowman Crawford,	*Chicago, Ill.*	33 Prospect st.
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Edwin Horace Forbes,	*Cromwell,*	20 York sq.
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Edward Benjamin Chandler,	*Woodstock*,	20 York sq. pl.
John Henry Chapman,	*New York City*,	48 College st.
Henry Grant Cheney,	*South Manchester*,	90 Grove st.
William Alexander Christie,	*Newport, R. I.*	29 Prospect st.
Arthur Eugene Clarke,	*Batavia, N. Y.*	159 Temple st.
Jocelyn Platt Cleaveland,	*New Haven*,	140 York st.
George Rufus Cooley,	*Hamden*,	353 State st.
Frederic Augustus Corning,	*Hartford*,	33 Prospect st.
Chambers McKibbin Craig,	*Alleghany City, Pa.*	8 Lock st.
James Cunningham,	*Pittston, Pa.*	149 College st.
Henry Sheldon DeForest,	*Birmingham*,	108 York st.
Charles Dickinson,	*Fordham, N. Y.*	205 Orange st.
Frank Alfred Ethridge,	*Rome, N. Y.*	11 College st.
Charles William Fenn,	*Portland, Me.*	7 Library st.
Frederic Hodgeman Foote,	*Port Henry, N. Y.*	23 Prospect st.
Charles Hamilton Fox,	*Lansingburgh, N. Y.*	147 York st.
James Freeland,	*New York City*,	120 College st.
Luther Henry Gager,	*Coventry*,	209 Elm st.
Robert Francis Gaylord,	*Sherman*,	E., D. H.
Livingston Gifford,	*Jersey City, N. J.*	116 College st.
Louis Emile Addison Goll,	*Newark, N. J.*	88 Wall st.
Frank Holabird Grant,	*Glastenbury*,	8 Elm st.
John Starr Griffing,	*New Haven*,	114 Chapel st.
William Cornelius Hall,	*Buffalo, N. Y.*	73 Trumbull st.
Henry Mortimer Hastings,	*Oswego, N. Y.*	132 College st.
Alfred Pell Haven,	*New York City*,	33 Prospect st.
Charles Hildebrand,	*New Haven*,	16 Chestnut st.
William Read Howe,	*Orange, N. J.*	64 Whitney av.

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Julian Kennedy,	*Struthers, O.*	91 Ashmun st.
Edward Austin Kent,	*Buffalo, N. Y.*	159 Temple st.
George Reinard Kleeberger,	*Apple River, Ill.*	6 College st.
Wells Cushman Lake,	*Lake Forest, Ill.*	72 High st.
Charles Purdy Lindsley,	*New Haven,*	132 Olive st.
Blanchard Lynde,	*Milwaukee, Wisc.*	33 Prospect st.
Albert Sutton Macgregor,	*New York City,*	11 College st.
William James McKee,	*Madison, Ind.*	11 College st.
Clarence Fake McMurray,	*Lansingburgh, N. Y.*	147 York st.
Burton Mansfield,	*New Haven,*	50 Lyon st.
Charles Aldworth Maybury,	*Norwalk,*	76 High st.
John Daniel Mersereau,	*Portville, N. Y.*	31 Prospect st.
Arthur Edward Nichols,	*Yonkers, N. Y.*	11 College st.
John Charles Olmsted,	*New York City,*	189 Church st.
John Robert Paddock,	*Cheshire,*	154 St. John st.
Frederic Noah Pease,	*Ellington,*	22 York sq.
William Edward Peirce,	*Raleigh, N. C.*	11 Grove st.
Dwight Edward Pierce,	*New Haven,*	120 High st.
George White Polk,	*Odessa, Del.*	72 Howe st.
William Arthur Pratt,	*New Haven,*	88 Howe st.
William Shugard Righter,	*Newark, N. J.*	177 Temple st.
Walter Coe Roberts,	*New Haven,*	8 Brown st.
William Babcock Sawyer,	*Buffalo, N. Y.*	116 College st.
James Alvin Scott,	*Naugatuck,*	172 George st.
Richard Sharpe,	*Eckley, Pa.*	72 Howe st.
Clarence Hoyt Stilson,	*Cleveland, O.*	96 York st.
Howard Steadman Talcott,	*Hartford,*	33 Prospect st.
William Allen Tremaine,	*Hartford,*	18 Mansfield st.
Charles Wall Truslow,	*New York City,*	22 York sq.
Frederick Moncrieff Turnbull,	*Hartford,*	18 Mansfield st.
George L. Upham,	*Yonkers, N. Y.*	92 Grove st.
Thomas Alfred Vernon,	*Brooklyn, L. I.*	7 Library st.
William Oakley Wallace,	*Ansonia,*	31 High st.
Alonzo Earl Wemple,	*Brooklyn, L. I.*	149 College st.
William Rodman Wharton,	*Germantown, Pa.*	432 Chapel st.
Alfred Newton Wheeler,	*Southford,*	59 Wooster st.
Henry Stacy Whipple,	*Birmingham,*	96 York st.
Edward Luther White,	*Waterbury,*	31 Prospect st.
George Horace Wilcox,	*West Meriden,*	25 Prospect st.
Frederick Wood,	*Norwalk,*	116 College st.
Kenjiro Yamagawa,	*Japan,*	11 Grove st.

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SPECIAL STUDENTS NOT CANDIDATES FOR A DEGREE.

Franklin Benner,	*Astoria, N. Y.*	164 York st.
Thomas Attwater Bostwick,	*New Haven,*	162 Olive st.
William B. Caldwell,	*Louisville, Ky.*	106 Wall st.
Edward Moses Child,	*Woodstock,*	20 York sq. pl.
Russell Henry Chittenden,	*New Haven,*	23 Humphrey st.
Fillmore Cogswell,	*Marble Dale,*	136 College st.
William James Dougherty,	*Washington, Ill.*	168 George st.
James Elliot Gregory,	*New York City,*	134 College st.
Franklin Wilson Hall,	*Killingworth,*	14 Park st.
William Lyman,	*Middlefield,*	Middlefield.
Frederick Anthony Marks,	*Wallingford,*	169 Temple st.
George Soulé Phelps,	*East Windsor,*	Wallingford.
William James Rattle,	*Cleveland, O.*	96 York st.
Archibald Rogers,	*New York City,*	120 College st.
John Howard Sherman,	*New Haven,*	Whitneyville.
Edward Henry Smith,	*Plainville,*	22 York sq. pl.
Sayeach Tsuda,	*Kumamoto, Japan,*	138 College st.
Samuel Traquair Tyson,	*Philadelphia, Pa.*	217 Crown st.

Special Students, 18.

SUMMARY.

Graduates,	28
Seniors,	27
Juniors,	48
Freshmen,	80
Special Students,	18
Total,	201

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SHEFFIELD SCIENTIFIC SCHOOL.

I.

Objects.

The Sheffield Scientific School is devoted to instruction and researches in the mathematical, physical, and natural sciences, with reference to the promotion and diffusion of science, and also to the preparation of young men for such pursuits as require especial proficiency in these departments of learning. It is one of the Departments of Yale College, like the law, medical, theological and art schools, having its separate funds, buildings, teachers, and regulations, but governed by the Corporation of Yale College, which appoints the professors and confers the degrees. It is, in part, analogous to the academic department or classical college, and, in part, to the professional schools.

The instruction is intended for two classes of students:—

I. Graduates of this or of other Colleges, and other persons qualified for advanced or special scientific study.

II. Undergraduates who desire a training chiefly mathematical and scientific, in less part linguistic and literary, for higher scientific studies, or for various other occupations to which such training is suited.

II.

History and Organization.

The School was commenced in 1847. In 1860, a convenient building and a considerable endowment were given by Joseph E. Sheffield, Esq., of New Haven, whose name, at the repeated request of the Corporation of Yale College, was afterward attached to the foundation. Mr. Sheffield has frequently and munificently increased his original gifts, and an additional building for the use of the School, the construction of which was begun by him more than a year ago, is now very near completion, and will be ready for use before the beginning of the next academic year.

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In 1864, by an act of the Connecticut Legislature, the national grant for the promotion of scientific education (under the congressional enactment of July, 1862) was given to this department of Yale College, which thus became "the College of Agriculture and the Mechanic Arts for Connecticut." Since that time, and especially since the autumn of 1869, numerous liberal gifts have been received from the citizens of New Haven, and from other gentlemen in Connecticut, New York, and St. Louis, for the endowment of the School, and the increase of its collections.

The action of the State led to the designation by law of a State Board of Visitors, consisting of the Governor, Lieutenant Governor, three senior Senators, and Secretary of the State Board of Education; and this Board, with the Secretary of the Scientific School, is also the Board for the appointment of students to hold the State scholarships.

At the request of the Governing Board, the Corporation of Yale College has also appointed a Board of Councillors for the School, consisting of a number of gentlemen who have taken a deep interest in its welfare, and have assiduously labored to secure its success.

The Governing Board consists of the President of Yale College and the Professors who are permanently attached to the School. There are several other instructors associated with them, a part of whom are connected with other departments of the College.

This peculiar organization, though somewhat complex, has been a natural growth of the last twenty-five years, and it may be added that the combination of a new department, with an old and well tried institution like Yale College has advantages for both. The establishment of a college of science has relieved the academic or classical college from all pressure tending to the establishment of "partial courses" of study, and has supplemented its means of instruction by new professorships and new scientific collections; while it has rendered further service by giving to graduates of the classical department opportunities for special and systematic professional training, distinct from those afforded in the schools of law, medicine, and theology.

III.

Building and Apparatus.

Sheffield Hall is a building containing a large number of recitation and lecture rooms, a hall for public assemblies and lectures, chemical and metallurgical laboratories, a photographical room,

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an astronomical observatory, museums, a library and reading room, besides studies for some of the professors, where their private technical libraries are kept. Up to a recent period it furnished sufficient accommodations for all the exercises of the School; but the rapid increase in the number of students has of late rendered it necessary to carry on much of the work of instruction in other places. To remedy this state of things, Mr. Sheffield has nearly completed a large and well-arranged building directly north of the present Sheffield Hall, which will be thoroughly furnished and ready for use by the beginning of the autumn term. A full description of this edifice can be found in the annual report for the current year.

The following is a summary statement of the collections belonging to the School:—

1. Laboratories and Apparatus in Chemistry, Metallurgy, Photography, and Zoölogy.
2. Metallurgical Museum of Ores, Furnace Products, etc.
3. Agricultural Museum of Soils, Fertilizers, useful and injurious Insects, etc.
4. Collections in Zoölogy.
5. Astronomical Observatory, with an equatorial telescope by Clark and Sons of Cambridge, a meridian circle, etc.
6. Library and reading room, containing the "Hillhouse Mathematical Library," books of reference, and a selection of German, French, English, and American scientific journals.
7. A collection of Physical Apparatus, constituting the "Collier Cabinet."
8. Models in Architecture, Geometrical Drawing, Civil Engineering, Topographical Engineering, and Mechanics; diagrams adapted to public lectures; instruments for field practice.
9. Maps and Charts, topographical, hydrographical, geological, etc.

The mineralogical cabinet of Professor Brush, the herbarium of Professor Brewer, the collection of native birds of Professor Whitney, and the astronomical instruments of Professor Lyman, are deposited in the building. Professor Eaton's herbarium, near at hand, is freely accessible.

Students are also admitted, under varying conditions, to the College and Society libraries, the College Reading Room, the Cabinet of Minerals and Fossils, the School of the Fine Arts, and the Gymnasium.

IV.

Instruction for Graduate and Special Students.

Persons who have gone through undergraduate courses of study, here or elsewhere, may avail themselves of the facilities of the School for more special professional training in the physical sciences and their applications, gaining in one, two, or three years

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the degree of BACHELOR OF PHILOSOPHY, or, in two additional years of Engineering study, that of CIVIL ENGINEER, or of DYNAMICAL ENGINEER.

Or, engaging in studies of a less exclusively technical character, they may become candidates for the degree of DOCTOR OF PHILOSOPHY. The instruction in such cases will be adapted to the particular needs and capacities of each student, and may be combined with that given by the graduate instructors in other departments of the University. This degree is conferred upon those who, having already taken a Bachelor's degree, engage as students in the Department of Philosophy and the Arts for not less than two years in assiduous and successful study. It is not given upon examination to those whose studies are pursued elsewhere. The requirements for it will in some cases exact of the student more than two years of post-graduate labor; so, especially, wherever the course of undergraduate study has been, as in the Scientific School, of less than four years. The candidate must pass a satisfactory final examination, and present a thesis giving evidence of high attainment in the branches of knowledge to which he has attended. A good knowledge of Latin, German and French will be required in all cases, unless, for some exceptional reason, the candidate be excused by the Faculty. The graduating fee is ten dollars.

Subjects likely to receive special attention are suggested as follows:—

Professor NORTON will instruct in the mechanics of rigid bodies and of fluids, and in spherical astronomy, including the computation of planetary and cometary orbits.

Professor LYMAN, in the use of meridional and other astronomical instruments, and in astronomical spectroscopy.

Professor TROWBRIDGE, in the principles of thermodynamics, or the artificial generation, transfer, and utilization of heat as a source of power.

Professor BRUSH, in the analysis and determination of mineral species, and in descriptive mineralogy.

Professor JOHNSON, in theoretical, analytical and agricultural chemistry.

Professor BREWER, in agriculture and forest culture, in the use of the microscope, and in physical geography.

Professor EATON, in structural and systematic botany, including the North American flora and the description of genera and species.

Professor MARSH, in palæontology and comparative osteology.

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Professor WALKER, in public finance, and in the statistics of industry.

Professor ALLEN, in analytical chemistry, and in metallurgy.

Professor VERRILL and Mr. S. I. SMITH, in zoölogy and geology.

Professor CLARK, in the general theory of equations, and in the differential and integral calculus.

The same courses of study are open, for a longer or shorter time, to graduate students who do not desire to become candidates for a degree.

The degrees of CIVIL ENGINEER and of DYNAMIC ENGINEER are conferred on Bachelors who have taken the first degree in engineering study, and who pursue specified higher courses for at least two years, sustaining a final examination, and giving evidence of their ability to design important constructions and to make the requisite drawings and calculations. The fee for each of these degrees is five dollars.

SPECIAL STUDENTS.—For the benefit of those who, being fully qualified, desire to pursue particular studies without reference to the obtaining of a degree, special or irregular students are received in most of the departments of the School (not, however, in the Select Course or in the Freshman Class).

It should be distinctly understood that these opportunities are not offered to persons who are incompetent to go on with regular courses, but are designed to aid those who, having received a sufficient preliminary education elsewhere, desire to increase their proficiency in special branches.

V.

INSTRUCTION FOR UNDERGRADUATE STUDENTS.

TERMS OF ADMISSION.—Candidates must be not less than sixteen years of age, and must bring satisfactory testimonials of moral character from their former instructors or other responsible persons.

For admission the student must pass a thorough examination in *Arithmetic*, including the Metric System; in Davies's Bourdon's *Algebra* as far as the General Theory of Equations, or in its equivalent; in *Geometry*, in the nine books of Davies's Legendre, or their equivalent; in *Plane Trigonometry*, Analytical Trigonometry inclusive; in *Geography*, *United States History* and *English Grammar*, including Spelling, and in *Latin*. In this last, six books of Cæsar's Commentaries, or their equivalent, as, for example, the prose of the first portion of Allen's Latin Reader closing

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with Sallust, is the least amount which will be accepted in the examination. After the examination of 1873, a knowledge of some text-book, containing simple exercises for translation from English into Latin, will also be required.

The examinations for admission take place at Sheffield Hall, on Saturday, June 21st, and Friday, June 27th, the Saturday preceding and the Friday following Commencement; and on Wednesday, Sept. 10th, 1873. Opportunity for private examination may, in exceptional cases, be given at other times.

Candidates for advanced standing in the undergraduate classes are examined, in addition to the preparatory studies, in those already pursued by the class they propose to enter. No one can be admitted as a candidate for a degree later than at the beginning of the Senior year.

COURSES OF INSTRUCTION, occupying three years, are arranged to suit the requirements of various classes of students. The first year's work is the same for all; during the last two years the instruction is chiefly arranged in special courses.

The special courses most distinctly marked out are the following:—

(a.) In Chemistry and Metallurgy;
(b.) In Civil Engineering;
(c.) In Dynamic (or Mechanical) Engineering;
(d.) In Agriculture;
(e.) In Natural History;
(f.) In studies preparatory to Medical Studies;
(g.) In studies preparatory to Mining;
(h.) In Select studies preparatory to other higher pursuits, to business, etc.

The arrangement of the studies is indicated in the annexed scheme.

FRESHMAN YEAR.—INTRODUCTORY TO ALL THE COURSES.

FIRST TERM—*German.*—Whitney's Grammar and Reader. *English.*—Hadley's Brief History of the English Language; Exercises in Composition. *Mathematics.*—Davies's Analytical Geometry, and Spherical Trigonometry. *Physics.*—Atkinson's Ganot, with experimental lectures. *Chemistry.*—Eliot and Storer's Manual; Laboratory practice. *Elementary Drawing.*—Practical Lessons in the Art School.

SECOND TERM—*Language, Physics, Chemistry, and Drawing.*—As stated above. *Mathematics.*—Church's Descriptive Geometry. *Elocution.*

THIRD TERM—*Mathematics.*—Surveying and Plotting. *Botany.*—Gray's Lessons. *Physical Geography.*—Ten Lectures on the Outlines of the Structure of the Earth. Other studies continued. *Drawing.*—Binn's Orthographic Projection.

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For the Junior and Senior years the students select for themselves one of the following courses:—

(a.) In CHEMISTRY AND METALLURGY.

JUNIOR YEAR.

FIRST TERM—*Theoretical and Organic Chemistry.*—Lectures. *Chemical Analysis.*—Fresenius. Use of Blow-pipe. *Laboratory Practice.*—Qualitative Analysis. Exercises in English Composition. *German. French.*

SECOND TERM—*Laboratory Practice.*—Qualitative Analysis, continued. Quantitative Analysis, begun. *Zoölogy.*—Lectures. Exercises in English Composition. *German. French.*

THIRD TERM—*Mineralogy.*—Dana's. Lectures and Practical Exercises. *Organic Chemistry.*—Lectures. *Zoölogy.*—Lectures and Excursions. *Laboratory Practice.*—Quantitative Analysis, continued. Exercises in English Composition. *French*—continued.

SENIOR YEAR.

FIRST TERM—*Metallurgy.*—Percy's. Lectures. *Geology.*—Dana's. Lectures and Recitations. *Zoölogy.*—Lectures. *Laboratory Practice.*—Volumetric and Organic Analysis. *Determinative Mineralogy.* Exercises in English Composition. *French*—continued.

SECOND AND THIRD TERMS—*Metallurgy.*—Lectures. *Agricultural Chemistry.*—Recitations and Lectures. *Geology.*—Dana's. *Laboratory Practice.*—Mineral Analysis and Assaying. *Determinative Mineralogy. French*—continued.

(b.) IN CIVIL ENGINEERING.

JUNIOR YEAR.

FIRST TERM—*Mathematics.*—Analytical Geometry of Three Dimensions. Church's Differential Calculus. Church's Descriptive Geometry, continued. *Surveying.*—Topographical and Hydrographic. *Drawing.*—Plotting and Chart Drawing. Exercises in English Composition. *French and German.*

SECOND TERM—*Mathematics.*—Differential and Integral Calculus. *Astronomy.*—Norton's Astronomy, with practical problems. Exercises in English Composition. *French and German.*

THIRD TERM—*Mechanics.*—Peck's Elements. *Surveying.*—Topographical. Topographical sketching in the field. *Drawing.*—Binn's Second Course of Orthographic Projections. Linear Perspective. Isometrical and Topographical Drawing. Exercises in English Composition. *French.*

SENIOR YEAR.

FIRST TERM—*Field Engineering.*—Laying out curves. Location of line of Railroad, with calculations of excavation and embankment. Henck's Field Book for Railroad Engineers. *Stone Cutting*—with graphical problems. *Mechanics.*—Mechanics applied to Engineering. *Geology.*—Dana's. *Drawing.*—Architectural. Exercises in English Composition. *French.*

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SECOND TERM—*Civil Engineering.*—Mahan's. Building Materials (Lectures). Strength of Materials. Bridge Construction. *Surveying*—with Plane Table. Geodesy. *Drawing.*—Mechanical. *French.*

THIRD TERM—*Civil Engineering.*—Bridge Construction, continued. Stability of Arches and Walls. *Dynamics.*—Principles of Mechanism. Steam Engine. *Hydraulics.*—Theory of Turbines and other Water Wheels. D'Aubuisson's Hydraulics. *Drawing.*—Structural.

Students pursuing a higher course in Engineering, for one year after graduating as Bachelors, may receive the degree of Civil Engineer.

(c.) IN DYNAMIC ENGINEERING.

JUNIOR YEAR.

Pure and Applied Mathematics.—Geometry of Machinery. Analytical Geometry of Three Dimensions. Differential and Integral Calculus. *Mechanics.*—Analytical Mechanics. *Drawing.*—Binn's Orthographic Projections. Principles of Construction. Shading and Tinting, and drawing from Patterns. *Metallurgy.* Exercises in English Composition. *French and German.*

SENIOR YEAR.

Applied Mechanics.—Strength of Materials. Theory of Machines. Theory and Construction of the Steam Engine and other prime movers. Mill work. Examination of Machinery. Mechanical Construction. Use of tools. *Drawing.*—Drawing from actual Machines. Designs of Machines. Exercises in English Composition. *French. Metallurgy.*

(d.) IN AGRICULTURE.

JUNIOR YEAR.

FIRST TERM—*Theoretical and Organic Chemistry*—Lectures. *Experimental and Analytical Chemistry*—in their Agricultural applications. Laboratory practice. *French*—begun. *German*—continued.

SECOND TERM—*Agricultural Chemistry.*—Recitations. *Experimental Chemistry.*—Laboratory practice. *French and German*—continued. *Physical Geography.*—Lectures. *Zoölogy.*—Lectures.

THIRD TERM—*Agricultural Chemistry.*—Lectures. *Horticulture and Kitchen Gardening.*—Lectures. *Mineralogy.*—Lectures and Practical Exercises. *Zoölogy.*—Lectures. *Experimental Chemistry.*—Laboratory practice. *French*—continued. *Drawing.*—Free-hand practice. *Excursions.*—Botanical, Zoölogical, etc.

SENIOR YEAR.

FIRST TERM—*Agriculture.*—Cultivation of the Staple Crops of the Northern States. Lectures. *Agricultural Zoölogy.*—Origin and Natural History of Domestic Animals. Insects useful and injurious to Vegetation. Lectures. *Geology.*—Dana's. *French*—continued. *Excursions.*—Agricultural, Zoölogical, Geological, etc.

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SECOND TERM—*Agriculture.*—Stock-raising and principles of Breeding. Lectures. *English. Human Anatomy and Physiology.*—Lectures. *French*—continued.

THIRD TERM—*Rural Economy.*—History of Agriculture and Sketches of Husbandry in Foreign Countries. Adaptation of farming to soil, climate, market, and other conditions. Systems of Husbandry. Stock, sheep, grain, and mixed farming. Lectures. *Excursions.*—Agricultural, Geological, Zoölogical, and Botanical.

(e.) IN NATURAL HISTORY.

(Either Geology, Mineralogy, Zoölogy, or Botany may be made the principal study, some attention in each case being directed to the other three branches of Natural History.)

JUNIOR YEAR.

FIRST TERM—*Zoölogy.*—Daily Laboratory instruction; Zoölogical Excursions. *Botany.*—Gray's Text-Book; Use of the Microscope. *Chemistry.*—Theoretical and Organic Chemistry. *French*—begun. *German*—continued.

SECOND TERM—*Zoölogy and Palæontology.*—Laboratory practice. Lectures. *Botany.*—Lectures; Gray's Text-Book. *Physical Geography.*—Lectures and Recitations. *Chemistry.*—Laboratory practice. *French and German*—continued.

THIRD TERM—*Zoölogy and Palæontology.*—Laboratory practice. Lectures, Excursions (land and marine). *Botany.*—Excursions. Practical exercises. Gray's Manual. *Mineralogy.*—Dana's. Lectures. Practical exercises. *French*—continued. *Drawing.*—Free-hand practice.

SENIOR YEAR.

FIRST TERM—*Language.*—Whitney's Language and the Study of Language. *French.*—Selections. *Zoölogy and Palæontology.*—Laboratory Practice. Lectures. Excursions. *Botany.*—Excursions. Herbarium studies. *Geology.*—Dana's Manual. Excursions.

SECOND TERM.—*Zoölogy and Palæontology*—continued. *Botany.*—Herbarium studies. Botanical Literature. Essays in Descriptive Botany. *Geology.*—Dana's. *Anatomy and Physiology.*—Academical Lectures. *French.*—Selections. *Whitney on Language*—continued.

THIRD TERM.—*Zoölogy, Botany, and Palæontology*—continued, with Excursions. *Photography.*—Practical instruction.

Besides the regular courses of lectures on structural and systematic Zoölogy and Botany, and on special subjects, students are taught to prepare, arrange, and identify collections, to make dissections, to pursue original investigations, and to describe Genera and Species in the language of science. For these purposes, large collections in Zoölogy and Palæontology belonging to the College are available, as are also the private botanical collections of Professor Eaton.

(f.) IN PREPARATION FOR MEDICAL STUDIES.

During the Junior year, the work of this course will be chiefly under the direction of the instructors in Chemistry. Especial attention will be given to qualitative and quantitative analysis, in their physiological and medical bearings; and to

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the preparation and study of the organic proximate elements. In the Senior year, the work will be chiefly under the direction of the Professors of Zoölogy and Botany. Attention will be paid in Zoölogy to comparative anatomy, reproduction, embryology, the laws of hereditary descent, and human parasites; and in Botany to a general knowledge of structural and physiological Botany, and to medicinal, food-producing, and poisonous plants. The studies of the Select Course in Physical Geography, History, English Literature, etc., are followed by these students.

(g.) IN STUDIES PREPARATORY TO MINING.

Young men desiring to become Mining Engineers, can pursue the regular course in Civil or Mechanical Engineering, and at its close can spend an additional year in the study of metallurgy, mineralogy, etc.

(h.) IN SELECT STUDIES PREPARATORY TO OTHER HIGHER PURSUITS, TO BUSINESS, ETC.

JUNIOR YEAR.

FIRST TERM.—*German, Anglo-Saxon and Early English, and Drawing*—continued. *French*—begun. Lectures and Exercises in Chemistry and Mineralogy. Physical Geography.

SECOND TERM.—*German, French*—continued. *English.*—Chaucer. *Astronomy.*—Norton's Astronomy, with practical problems. *Modern History.*—Recitations and Lectures.

THIRD TERM.—*French*—continued. *English.*—Shakespeare. *Mechanics.*—Peck's Elements. *Botany and Zoölogy.*—Lectures and Excursions.

SENIOR YEAR.

LANGUAGE.—The study of French is continued through the year, and during the first two terms there are recitations in Whitney's Language and the Study of Language. In English, Shakespeare, Milton, Dryden, and Pope are the authors studied throughout the year, and in the order here named.

NATURAL SCIENCE.—The study of Geology is pursued by recitations, lectures and excursions. Lectures are given in Rural Economy and the Principles of Agriculture, and also in Agricultural Chemistry. Botany is studied during the early part of the autumn term.

HISTORY, GEOGRAPHY, AND POLITICAL ECONOMY.—Lectures, Recitations, and Exercises will be continued through the year.

Exercises in English Composition are required during the entire course from all the students. During the Senior year, the preparation of the thesis occupies the attention of the class.

Lectures on Military Science and Tactics are annually given.

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VI.

Lectures.

The instructions of this institution are given chiefly in small class rooms, by recitations or familiar lectures, illustrated by the apparatus at the command of the various teachers. A public course of lectures is given every winter on topics of popular interest. On Sunday evenings, during a portion of the year, lectures are given by resident clergymen of different denominations, and by members of the Scientific and other college faculties.

VII.

Tuition Charges.

The charge for tuition is $150 per year, payable $55 at the beginning of the first and of the second term, and $40 at the beginning of the third term. The special student of Chemistry has an additional charge of seventy-five dollars per annum for chemicals and use of apparatus. He also supplies himself at his own expense with gas, flasks, crucibles, etc., the cost of which should not exceed ten dollars per term. An additional charge of five dollars is annually made to each student for the use of the College Reading Room and Gymnasium.

VIII.

Church Sittings.

Free sittings for students in this department of Yale College are provided as follows:

In the Center Church (Cong.), Rev. G. L. Walker, D.D.: Pews No. 36 and 42, in the North Gallery.

In Trinity Church (Episc.), Rev. E. Harwood, D.D.: Pews No. 175 and 177, in the North Gallery.

In the First Methodist Church, Rev. G. W. Woodruff, D.D.: Pew No. 78, at the head of the West Aisle (below).

Any of the students may occupy a sitting in these slips. Those who prefer to pay for a sitting for a year, more or less, in the churches above mentioned, or in any other church of any denomination, will be aided on application to the Secretary of the School.

Sittings in the Gallery of the College Chapel are free as heretofore to the students of this department.

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IX.

Degrees.

Students of this department, on the recommendation of the Governing Board, are admitted by the Corporation of Yale College to the following degrees. They are thus conferred:

1. Bachelor of Philosophy: on those who complete any of the three-year courses of study, passing all the examinations in a satisfactory manner, and presenting a graduation thesis.

The fee for graduation as Bachelor of Philosophy, including the fee for Triennial Catalogues, Commencement Dinners, etc., is ten dollars; unless the person taking the degree is also an academical graduate, when it is but five dollars.

2. Civil Engineer and Dynamic Engineer: The requirements for this degree are stated on page 17.

3. Doctor of Philosophy: The requirements for this degree are stated on page 16.

X.

Terms and Vacations.

The next academic year begins Thursday, September 11, 1873. Examinations for admission Saturday, June 21, Friday, June 27, and Wednesday, Sept. 10. The vacations correspond with those of the Academical Department, giving two weeks at Christmas, two weeks in the Spring, and ten weeks in the Summer.

XI.

Explanation of some of the Studies.

In explanation of some of the studies which are pursued by the Select Course students, and are more or less attended by the students of other courses, the following statements are given. Post-graduate students may, at their option, attend the exercises here referred to, when the hours do not interfere with their other specialties.

Botany.

The study of Botany begins in the summer of Freshman year, with recitations from Gray's Lessons on Structural and Physiological Botany, illustrated by examples from nature.

In the summer of Junior year, exercises in analyzing and identifying plants occur two or three times a week, followed by practice in writing characters and descriptions of plants from living

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specimens. Students are shown also how to collect and preserve specimens for future use, several Natural Orders being especially indicated to each class for special work in collecting. Excursions every Wednesday.

In the autumn term of Senior year, the work of the summer is continued. Students will now begin to write generic as well as specific characters, and at the close of the term an essay on some one Natural Order will be required. During the second and third terms, a Herbarium of the indicated Natural Orders will be prepared and presented for examination at the end of the year.

In the same terms a course of lectures on Botany is given to the Senior Class of the Academical Department, and the Seniors of the Select Course are expected to attend these lectures.

Zoölogy.

The instruction in Zoölogy consists of the following courses:

a. In the second term of the Junior year, a course of lectures on Comparative Anatomy and Physiology, and the Principles of Zoölogy. The students are required to take notes, and are questioned at the beginning of each lecture upon subjects of the previous one.

b. During the third term of the Junior year, a course of lectures upon systematic Zoölogy, including the structure, classification, metamorphoses, and habits of animals. This course is intended partly as a preparation for Geology.

c. Weekly excursions during the third term of Junior and first term of Senior year, in company with the instructors, for the purpose of observing the habits and making collections of marine, fresh-water, and terrestrial animals of all classes. Each student is required to prepare and present for examination a collection containing a specified number of species, and illustrating the various classes of animals. He must also be able to pass an examination upon his collection, at least to the extent of explaining the classes illustrated, and showing why particular specimens belong to their respective classes.

d. During the first term of the Senior year, lectures on various special subjects, such as Domestic Animals, the Laws of Reproduction and Breeding, Embryology, Theories of Evolution, Geographical Distribution, and Applied Entomology.

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Geology.

The instruction in Geology is as follows:

a. During the first and second terms of the Senior year, recitations three times a week in Dana's Manual, illustrated by numerous specimens of minerals, rocks and fossils, and also diagrams and charts.

b. Excursions into the country in the first term to examine Geological phenomena, and to see the rocks in place.

c. Frequent visits to the Geological collections in company with the instructor, for the purpose of seeing larger series of fossils than can be exhibited in the class room.

Physical Geography.

In the third term of Freshman year, a course of ten or twelve lectures, with questions and drill upon the maps, will be given, as an introduction to Physical Geography and a review of elementary studies. These exercises will chiefly relate to the globe in its entirety, and to the separate continents.

In the Junior year, the study of a text-book will be followed with illustrative lectures, and practical lessons upon the globe.

In the Senior year, the careful study of the continents of Europe and North America will be taken up, chiefly with reference to their physical peculiarities, but with an incidental regard to national progress.

XII.

LATIN.

The requirement of a certain amount of Latin as preparation for entrance into the Sheffield Scientific School causes so many inquiries that a few words of explanation of its nature and purpose seem called for.

First, as regards its reason. This is partly the intrinsic value of the Latin itself, partly its value as a preparation for other studies pursued in the School. That its acquisition is of great practical importance to educated men in every department is obvious. Were it only that almost all scientific nomenclature and phraseology is founded upon it, this would be reason enough for its inclusion among the studies of scientific men. An additional reason is that so much of our ordinary English speech is also of Latin origin. A man can no more claim to have enjoyed a fairly

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liberal education—an education that shows him the foundation and relations of things, and gives him command of useful instruments for further knowledge—without Latin than without German or French.

The language studies pursued in the School are mainly German and French. As things are at present in the preparatory schools, we are obliged to commence work upon those two languages with the very rudiments. But we need something that shall give our pupils a degree of practice and facility in taking hold of a strange language, in order to bring them to those others with a certain preparation, and enable them to make more rapid and equal progress. Nothing in this way is so useful as a little thorough training in the Latin Grammar and in Latin translation. Moreover, this training is more universally and readily accessible than any other. The text-books are all that could be desired, and every good school, and almost every community furnishes teachers who are qualified to help the beginner. And even if such helps were wanting, no capable and energetic young man need be afraid to take up a Latin grammar, and master by himself enough of it to begin reading.

As to the amount, we do not venture yet to require much—only the essential parts of the grammar, and ability to read and construe with intelligence some Latin author, such as Cæsar, or Virgil, or Sallust, or Cicero; this can be learned without difficulty by making the study one of those pursued through the year before entering.

XIII.

Announcement in Respect to State Students.

The scholarships established in this School in consequence of the bestowal upon it of the Congressional grants are designed to aid young men who are in need of pecuniary assistance in fitting themselves for agricultural and mechanical pursuits of life. All applicants must be citizens of Connecticut. In case there are more applicants than vacancies, candidates will be preferred who have lost a parent in the military or naval service of the United States, and next to these such as are most in need of pecuniary assistance; and the appointments will be distributed as far as practicable among the several counties in proportion to their population. The Appointing Board for the current year, consisting of the Board of Visitors of the State and the Secretary of the School, will meet on

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June 23, 1873, and at about the same time in the year 1874, due notice of which will be given by publication in every county of the State. All applications should be made previous to that time. Blank forms for application will be sent, when requested, by Professor GEORGE J. BRUSH, Secretary of the Appointing Board.

XIV.

ANNIVERSARY.

The Annual Meeting of the State Board of Visitors occurs in the second term, this year on Thursday, March 20th. The Anniversary of the School is held on Monday of the Commencement week in Yale College, June 23, 1873, when selections from the graduation theses are publicly read. The degrees are publicly conferred by the President and Fellows of Yale College on Commencement Day.

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State Board of Visitors.

CONSTITUTING, WITH THE SECRETARY OF THE SCHOOL, THE BOARD FOR THE APPOINTMENT OF STATE STUDENTS.

GOVERNOR.

His Exc. CHARLES R. INGERSOLL, New Haven.

LIEUTENANT-GOVERNOR.

His Honor GEORGE G. SILL, Hartford.

STATE SENATORS.

Hon. JOHN W. STOUGHTON, South Windsor.
Hon. GEORGE M. LANDERS, New Britain.
Hon. ZERAH FAIRMAN, Newtown.

SECRETARY OF STATE BOARD OF EDUCATION.

Rev. BIRDSEY GRANT NORTHROP, New Haven.

Councillors.

APPOINTED BY THE CORPORATION OF YALE COLLEGE.

Hon. JAMES E. ENGLISH, New Haven.
Hon. MARSHALL JEWELL, Hartford.
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Hon. OLIVER F. WINCHESTER, New Haven.
JOSEPH E. SHEFFIELD, Esq., New Haven.
Prof. JAMES D. DANA, LL.D., New Haven.
HENRY FARNAM, Esq., New Haven.
M. DWIGHT COLLIER, M.A., St. Louis.
Hon. WILLIAM E. DODGE, New York City.

SECRETARY AND TREASURER OF THE SCHOOL.

GEORGE J. BRUSH.

JANITOR OF SHEFFIELD HALL.

ANTON PFEIFER, 55 Lock street.

JANITOR OF NORTH SHEFFIELD HALL.

GEORGE W. STODDARD, 167 Columbus street.

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NINTH

ANNUAL REPORT

OF THE

SHEFFIELD SCIENTIFIC SCHOOL

OF

YALE COLLEGE,

New Haven, Conn.

1873–74.

PRINTED BY ORDER OF THE GENERAL ASSEMBLY.

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1874.

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1874, Dec. 29.
From the
Presidents Office.

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REPORT OF THE STATE BOARD OF VISITORS.

To the General Assembly of the State of Connecticut:

THE State Board of Visitors of the Sheffield Scientific School respectfully report that they have visited that institution during the past year, as required by their duties.

They have found the School in a high state of efficiency, its number of scholars never larger, its corps of able instructors zealous and faithful, and fully determined to keep it the leading school of science in the country, a position which it is now generally conceded to hold.

But its condition is so fully set forth in the accompanying report of the Governing Board, that a detailed statement of its affairs here would be superfluous. It is fully carrying out the noble design of its founders and benefactors, and contributes in large measure to the intellectual culture of our State.

In behalf of the Board,

CHARLES R. INGERSOLL,
Chairman.

BIRDSEY G. NORTHROP,
Secretary of the State Board of Education.

NEW HAVEN, May, 1874.

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ANNUAL STATEMENT

OF THE

GOVERNING BOARD.

In presenting their Ninth Annual Report the Governing Board are again enabled to bear witness to the increasing prosperity of the Sheffield Scientific School, and to express their gratification at the appreciation and favor which it still continues to receive from the public. While the past year has not been marked by any eventful changes, much of the interior working of the school has undergone thorough and careful revision. The increased accommodations presented by the new building not only enabled the Governing Board to carry on, for the first time in many years, the instruction entirely upon their own ground, but to furnish facilities for study and investigation which could not previously be afforded. In particular, the course in drawing has now been organized on a scale commensurate with its great importance; the laboratories for the study of chemistry and determinative mineralogy have been nearly doubled in size; and an entire reorganization of one of the special courses has been made and will go into effect during the coming year. A description of the changes which have been effected and the events which have taken place will be given in detail, beginning with the formal opening of the new building.

Opening of North Sheffield Hall.

The new building, a description of which can be found in the last Annual Statement, was formally opened on the afternoon of Wednesday, June 4, 1873. The General Assembly of the State, then sitting at Hartford, adjourned for the purpose of attending the exercises. At three o'clock the invited guests, consisting of the State officers, the members of both branches of the Legislature, the members of the Corporation and of the various faculties of Yale College, and numerous citizens, friends of the school, assembled in the lecture room of the new building. The platform

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was occupied by President Porter, ex-President Woolsey, Governor Ingersoll, ex-Governor Jewell, minister to Russia, ex-Governor Hawley, ex-Governor Buckingham, and Professor Brush. An abstract of the speeches delivered upon the occasion is here given. Professor Brush, as executive officer of the School, made, in behalf of the Governing Board, the formal address of welcome to those present, and in behalf of Mr. SHEFFIELD the formal presentation of the building to President Porter as the representative of the University, as follows:

The Governing Board of the Sheffield Scientific School feel honored to welcome his Excellency, the Chief Magistrate of the State, and other State officers, the members of the General Assembly, the President and Fellows of Yale College, and the several faculties of the University, together with other friends from far and near, to enjoy with them the opening of a new building—the gift of our munificent patron, Mr. JOSEPH E. SHEFFIELD.

The growth of the Scientific School in the number of students, and the increase of apparatus and collections, made it necessary, three years ago, to colonize the department of Mechanical Engineering, and through the courtesy of the director of the Yale School of the Fine Arts, Prof. Weir, we were generously accorded quarters for this purpose in the basement of the Street Art Building. The Laboratory of Zoölogy was likewise located off our grounds in the basement of the old Trumbull Gallery, and Botany had no foothold except in the professor's private residence. At this time we were sorely pressed for means to keep together our band of instructors, and, although our faith never wavered in regard to the ultimate success of the school, we did not dare give expression to the fears we then entertained that the growth of the institution in the immediate future would require accommodations which we should be unable to furnish.

Very soon, almost coincident with this, however, our generous friend, appreciating the situation, without a suggestion save the promptings of his own noble heart, quietly, as is his wont, informed us that he had deeded to the school the lot of land where this building now stands, and that it was his purpose at an early day to erect thereon a suitable building.

Mr. Sheffield gave no instructions in regard to the building, other than that it should be well adapted for the use of the institution. A committee was appointed, and to it he entrusted the character of the design, the making of the contracts, and the entire furnishing and fitting up of the interior of the building. The members of the committee have given the building their constant attention, and they believe that you will all recognize how greatly they have been indebted to the skill and taste of the architect, Mr. Cady of New York, and to the conscientious fidelity of the contractors, Messrs. Perkins & Chatfield, and Mr. Charles Thomp-

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son, of this city, in every detail of construction. We consider ourselves very fortunate in having had such disinterested men associated with us.

The building contains this lecture room and four recitation rooms on the first floor; two large rooms, temporarily used as drawing rooms, in the basement; a lecture room and laboratory for Physics, and drawing, model and recitation rooms for Civil Engineering, on the second floor; a laboratory for Zoölogy and also another for Botany, and drawing, model and recitation rooms for Mechanical Engineering, and private studies for professors, on the third floor; and in the attic, or fourth story, a large drawing room for the Freshman class, and dormitories for assistants.

With this brief statement of facts, I now, sir, as the representative of the Building Committee, and through them of Mr. Sheffield, tender to you, the President of our University, the use of this land and building for the purposes of the Sheffield Scientific School, and, representing the Governing Board, I ask that this building may be known as NORTH SHEFFIELD HALL.

The gift of the building was acknowledged by President Porter in a speech, of which the following summary is given:

Next to the blessing of giving is the satisfaction of receiving. It is with great satisfaction that I acknowledge, in the name of the college, the generous gift of Mr. Sheffield. I will not speak of its many excellencies, for it has spoken for itself to all who have seen it. I think I can safely say that it is without a rival in the country. Much honor is due to the architect, much to the committee, and much to the builders, who have conscientiously and faithfully performed their parts. There is wrought in this building more than is seen. It stands as a testimonial of the value of the school itself, since it shows in every part what science can do for the convenience of man. It is valuable also for the sake of the giver. We are pleased to receive benefits which show that those who have passed away have thought for the welfare of those who were to come after them. We are doubly pleased when we take gifts warm from the hand of the living giver, especially when, as in this case, it crowns a long series of benefactions. I regret that his sensitive modesty has kept him away from this gathering, so that he cannot see how deeply we appreciate his generosity. It has been given to many to aid institutions of learning, but it has been given to none to meet the opportunity so generously, so modestly, and so perseveringly. The President then spoke of the wonderful growth of the school, from the time when it was struggling for existence in its old wooden house on the college green, following it up through its course until Mr. Sheffield became connected with it, and met its successive wants. He honored the noble man who had been spared to see this day. It was not for any want of interest in these exercises that he was absent. The President then referred to the presence of a great portion of

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the Legislature. He was glad that they were present to see the good fruits of their help for the past ten years. He thought that the State had received as much as it had given. He was glad to be able, in the presence of the faculties of the university, to express in their name the fraternal feeling and kindly interest which was felt by each and all for every department. There is no jealousy between the old and the new educations. The old has much to learn from the new, and I do not doubt that the new will take from the old that which it has to give. I am delighted that the realism of science and of practical life has been brought into connection with the memories of history. In the presence of all these faculties, I hail and rejoice in the prosperity of the school.

At the conclusion of his address, President Porter called upon Governor Ingersoll. The Governor said:

Mr. President—It is particularly pleasant for me that I appear here not only as an inhabitant of the State of Connecticut, but also as a townsman and a graduate of the institution with which you are connected. To-day marks an epoch in the life of the school. You are right in saying that there is no jealousy between the old and the new. This benefaction is but a repetition of the benefaction of that other great merchant who founded Yale College. But in the seventeenth century through a study of the dead languages lay the only path to knowledge. Learned men then lived for the most part in the clouds. But in course of time the fire was brought from the heavens down to the earth, and now any one who thoroughly understands his own tongue is able to master nearly every branch of knowledge. From this institution the State has derived especial advantage. We used to hear much about the pauper labor of Europe and the impossibility of competing with it. We do not hear this now, for it is widely known that it is not pauper labor we have to fear, but skilled labor—the work of the brain. This change in general feeling must be attended with great material advantage to the State, and it has been produced by the influence of this institution and institutions like this. I have already detained you too long, but I must not stop without a word of tribute to the man to whose munificence and foresight we owe this building. We know of him, as fellow townsmen, in a way I hardly dare to trust the dictates of my heart to speak of. We remember how he came to this city as a retired man of business. Since that time his life has been marked, not by years, but by great and splendid gifts to this city, and for these, and in connection with these, his name will live as long as history.

At the conclusion of Governor Ingersoll's address, President Porter remarked that in 1846 Dr. Woolsey was chosen President of Yale College, and at the same time the department of Philosophy and the Arts was organized with two professorships; and out

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of this small beginning had grown the Sheffield Scientific School. He called upon Dr. Woolsey, who spoke as follows:

If testimony and recollection of what took place from the beginning is required, then I am, perhaps, the fittest person to speak of these things, for I was present, so to speak, at the birth of this school. But after what has been said I do not think it necessary to add any testimony in regard to the school in its struggling infancy. But there is another point in regard to which I wish to give emphatic testimony. I have been thoroughly acquainted with the energetic efforts of the professors for its advancement. From the first they have struggled against probabilities. They have worked by faith. They have aimed to have a school, sink or swim, worthy of the science of this country. During all these twenty-six or twenty-seven years their constant aim has been to raise the standard of admission, to increase the excellence of the course of instruction, to raise the standard of the examinations for degrees, and in fact to raise the standard of the school in every particular. As a result, I think that there is, confessedly, no other school of this character, in this country, which is on a level with this. Two elements are necessary to the constitution of any public place of learning—the spiritual and the corporeal. By the latter I mean the places of instruction, the apparatus, the books, and all that is necessary for conveying instruction to the student. In early times the corporeal was of little value on account of the prevalence of the simple lecturing system, as at Bologna. Professors had lecture rooms at their own houses, and gave lectures and took fees. Now, what can we do without books, apparatus and other conveniences for helping the understanding of the student? But notwithstanding the importance of conveniences, the great thing is the spirit—the ability, energy and self-sacrificing devotion to science of the professors. I have watched the efforts of the professors to make this school worthy of the country and the nineteenth century, and I would give equal honor to their devotion and to the munificence of the giver.

At the conclusion of Dr. Woolsey's address, President Porter said the audience had often enjoyed Governor Jewell's finished use of the English language, and in consideration of the fact that he was soon going where he would not have much chance to use his mother tongue, he called upon him to take advantage of this opportunity. Governor Jewell said:

I think that I and other outsiders appreciate more fully the value of this institution than do those who have graduated from it; and the proof of this lies in the fact that many of the most munificent gifts to the college have come from those who did not in youth enjoy its benefits. Coming, as I do, directly in contact with labor, I see that the great problem of labor and

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capital must be solved by increasing the productive power of the latter; and it is by the agency of institutions like this that this productive power is most rapidly and surely developed. It gives me pleasure to bear witness also to the spirit which the managers of this school have invariably exhibited ever since I have been acquainted with it. It was to me at first a novelty and surprise. I well recollect the first time I met with my associates as a member of the Yale corporation. I had been in many corporations, and was thoroughly acquainted with them and the nature of their proceedings. But those were business corporations, and at their meetings I had been accustomed to many applications for increase of salary. In fact, such applications were the most common thing in the world. But now I was in a different atmosphere. I was astonished at that meeting to see eight or ten applications from professors of this school praying, not that their salaries—little enough at best—might be increased, but that they might be decreased, in order that the money thus saved might be employed to render more efficient the instruction here given. I thought the good time coming of which we have so often heard was the good time come; and I saw in that one act of devotion and self-sacrifice the proof of that spirit which has placed this institution at the head of the Scientific schools of this country, and which I feel confident will continue to keep it in that position.

At the conclusion of Minister Jewell's address, the President introduced ex-Governor Joseph R. Hawley, who said:

I am only repeating what is always said on such an occasion, when I say I am glad to be here. But it is true; and the great reason why I rejoice is that I see that rich men are beginning to find out what to do with their money. If any man will take a look at my friend General Walker's statistics, showing plainly the prevalence of ignorance in the country, he will see the need of education. If he then looks to see what has been done, he finds that the two greatest institutions of learning, Yale and Harvard, worth perhaps $3,000,000 each, have been struggling along for years, and keeping alive only through the efforts of the self-sacrificing men who compose their faculties. He then takes a look at the New York Central Railroad with its capital of $100,000,000. How much would the cost of a single man-of-war benefit one of these institutions, and have an influence forever, while the ship would soon rot away? He looks around on manufacturing enterprises, and finds that one of these, confined to a few small buildings, has a capital exceeding the capital of Yale. He sees a lamentable under-estimation of some things and over-estimation of others. What then ought Yale to have? What it needs, if it be $10,000,000 or $20,000,000. Many persons could give this amount and not feel it—yes, they would feel it, they would feel better, here and hereafter. This university never should want for any-

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thing. It should be entirely beyond interference from without and fear of any kind. Seven years ago I was present at a little meeting in the library, when great fear was expressed lest the school should lose some of its best men. The question was, shall the school go on, try to get money, and live, or shall it die? I listened, and at the close of the meeting I told them I knew they would succeed, on account of a beautiful fanaticism which I saw there—a mutual pledging, a determination to get money somehow. And those men, aided by Mr. Sheffield, have placed the school where it is. It is the best school of its kind in the country, and I say this on the testimony of men of science who know. If it is not, it must be made the best. If there are others better, the country is to be congratulated. I am glad there is no clash between the old and the new. There is room for both. I have just been reading a work by Matthew Arnold. I had heard before of his "sweetness and light," but I find his sweetness very sour. [General Hawley then read certain passages relating to this country.] He belongs to that class of persons who think it the *summum bonum* of existence to lie in the sunshine and suck sugar. He would cultivate his intellectual finger nails until they ran into the ground. I believe that the men who *do* something have a moral sweetness and light superior to this. Man was not made to sit in a closet, as Mr. Arnold would have him, and make himself beautiful. He is only a unit of the great whole, which it is his business to better.

The President then called upon Senator Buckingham, who spoke as follows:

When I have turned my attention to your honored citizen, the testimony of whose liberality we see here to-day, I have rejoiced at his prosperity and have been glad that he has known so well how to use his money. The value of a knowledge of science is felt in every department of life. The physician cannot get along without a knowledge of chemistry. The lawyer must know something of mechanics in order to defend his clients' inventions. My own ignorance of chemistry caused me to lose more in the dye house, during eighteen years in which I was manufacturing carpets, than I made in all the rest of the establishment. I would say for the benefit of Professor Brewer that I believe the time will soon come when the farmer will raise more on ten acres than the majority of them do now on one hundred. These are the benefits we reap. Dr. Woolsey will live to see more young men coming to this department than to the academic. These young men are to be our public men of the future. This institution is to control the business and make the laws of this commonwealth. Do you wonder that, with this belief, I am envious? There is a remedy for this envy, however. It is this—give money, voice and all your energies for the support of the school.

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Charlton M. Lewis of New York being called upon, responded as follows:

It is fitting, perhaps, that I should be called upon at this particular time, for the progress of the speeches has been from the abstract to the practical. Some months ago I met in New York one of those moneyed men of whom General Hawley has spoken, able to give an amount of money equal to the value of Yale's property, and not feel it. I talked with him about the Scientific School and its wants, and what a magnificent future was in store for him who was so fortunate as to give largely to it. He said he had often thought of this, and in the course of our conversation he unbosomed himself to me so that I thoroughly understood him. He labored under a sense of responsibility, in regard to his wealth, which was oppressive. He really deemed it his paramount duty to increase the rate of interest at which his fortune has been accumulated. Now this is the age of the study of political economy, and when men feel as this one did we must subject the school to the general test. We must prove to them that money put here is better invested than anywhere else. What was the best investment made in the first century? I think we shall all agree that it was the money spent on St. Paul's education. And so with Luther and Lord Bacon. So can be said in future of the graduates of this school, if, as no one doubts, skilled labor is worth more than that which is unskilled. Science has a wonderful influence. No man can tell how much difference it will make in the future to take now one man out of the ranks of ignorant labor, and by training place him among the thoughtful, who are the leaders. This money of Mr. Sheffield's is doing more than the money invested by capitalists in means of communication and like enterprises. And if this is true now, how much more so will it become in the future.

At the conclusion of the addresses, the audience were invited to pass through and inspect the building; after which a collation was served up in the drawing-room in the fourth story. With this the exercises of the day ended.

Extension of the Course in Drawing.

Although drawing has to a greater or less extent been made a part of the system of instruction given in the school from the foundation of the Engineering section, it has been long felt by the Governing Board that more systematic and prolonged training should be imparted in this branch than has been actually the case. For a person whose occupation rarely demands even a rough sketch of the simplest forms, a mere knowledge of the elements of this art, with a small amount of practice, may suffice. But when

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drawing constitutes, as it does now in many scientific professions, the principal means of expressing ideas and imparting knowledge, thoroughness of training in this branch of instruction becomes of the first importance. It was evident that the methods employed in the institutions in this country had thus far failed to develop the same degree of excellence that is to be found in young men who come to us from abroad. Our manufacturing establishments, our public works, and offices, have found it to their advantage to employ for the positions requiring most skill in drawing, young men who had been trained in European schools. The deficiency evidently did not lie in our students; on the contrary, there is no branch of learning which they enter upon with more eagerness or pursue with more earnestness. It was felt that the defect must lie in the course of instruction adopted, and in the want of thoroughness in carrying it out; and in one particular the erroneousness of the methods commonly pursued was conspicuously manifest. The geometrical basis of the art, Descriptive Geometry, is commonly taught as an abstract science at the blackboard, or by simply requiring the drawing of the problems by means of drawing instruments; and after a few lessons from models, the student is perhaps allowed to copy, at will, complete drawings, or to attempt the more difficult process of composing a structure of which he does not understand the principles, and has not the requisite knowledge for adjusting the proportions and parts. As he speedily finds that he is beyond his depth, and that he has not the power of executing properly what he has designed, he naturally becomes dissatisfied. The only resource left him is to make pictures; and he bestows his greatest care on the fineness of the lines and the delicacy of shading. He does not acquire the power of delineating readily the internal as well as external parts of a structure by projecting them orthographically upon any plane, by the representation of lines of penetration, or the elements of surfaces. If these are known at all, they are only known theoretically, and he finds when his course is completed, and he is brought into contact with the practical problems of his profession, that the instruction he has received has been of little benefit.

The importance of putting this course upon a more satisfactory basis has for some time been made more and more apparent to the Governing Board; and the facilities furnished by the new building gave them the opportunity to carry into effect the plans

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that were entertained. A committee was appointed to consider the whole subject, and the course of instruction which it recommended met the approval of the entire body, and went immediately into effect. This course is intended not only to furnish the ground-work of principles drawn from descriptive geometry and the conventional symbols of representation, but to lead the student by successive steps through the whole range of the application of these principles. At each step such an amount of actual practice is required as to impress the knowledge gained of the principles permanently upon the mind. The course for one year is obligatory upon all students; for those purposing to devote themselves to Engineering or Architecture it extends through three years, and is divided up in the following manner. The first half year is devoted exclusively to

Free-hand Drawing,

this being placed at the beginning for the purpose of familiarizing the student with the use of the pencil, and by this means preparing him for the ever-recurring demands which his subsequent instruction makes upon this use; but more especially for the sake of training the eye and understanding to see correctly without mechanical aids. This course is carried on at the Yale School of the Fine Arts, and is under the direction of Professor J. H. Niemeyer of that department. It begins at once with the human figure, which has been simplified and reduced to geometrical bases; that is, the human figure, or any part of it, is embraced within the limits of right lines and angles. A student, therefore, in drawing, for instance, the profile view of a head, constructs the general proportions by bounding the forehead, nose, lips, chin, and other points, with straight lines. To do this he necessarily judges of the direction and length of one line and places it accurately upon the paper; he then observes the angle that another line forms with it, and so goes on, until he has constructed the whole figure. These right lines are then given a more definite expression by drawing other lines through them, to determine the character of the form represented. Well-directed training and close application will soon develop in the student the power to judge of form and proportion with accuracy, and to represent them with precision. The human figure has been adapted to this exercise, because in it, to the abstract idea of a right line, may be added the interest which character and expression give, and also because disproportions are more easily discovered in this than in

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any other object in visible nature. This course is obligatory upon all students, and is completed by the middle of the second term. It is immediately followed by the course in instrumental drawing.

The general nature of the course in

Instrumental Drawing

may be briefly stated, as follows. It begins with the elements of Descriptive Geometry practically applied to the projections of plane surfaces. No models are employed, and every student is obliged to go through precisely the same course, the practical problems being varied so much as to prevent any mere copying by one from another. Binns' Course of Orthographic Projections is adopted as the basis of instruction, though no actual study of the book is required. The Elementary Course, which follows directly upon the course in free-hand drawing, includes all difficult projections of points on vertical and horizontal planes, the projection of sections, the projection of the lines of penetration of solids, and generally the power of dissecting a solid and representing all lines and surfaces, whether concealed or visible, by the proper geometrical methods of construction, combined with the established conventional features of the art, upon planes of projection. In this it is rarely necessary to give assistance to the imagination by means of models, and it is never desirable if it can be avoided. This elementary course embraces twenty-three plates or sheets, each sheet constituting the exposition of some principle or process, with numerous variations or modifications Descriptive Geometry as an abstract study does not precede the Elementary Course, but is introduced after the student has become familiar with the practical methods of working, and is able to draw accurately, and without mere copying, the necessary figures. Indeed, the Elementary Course of Binns' Orthographic Projections and the first problems of Descriptive Geometry are in reality practical and theoretical expositions of the same general ideas, and should therefore be closely connected by being embraced in the same scheme and taught by the same instructor or instructors. In a corresponding manner the more difficult problems of Descriptive Geometry, including warped surfaces, are brought into the second year's course.

The twenty-three plates comprising the Elementary Course, but not including the problems of Descriptive Geometry, are divided as follows:

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The first nine sheets relate to the projections on horizontal and vertical planes, of points, right lines, surfaces bounded by right lines, solids bounded by plane polygons, and the intersection of such solids by planes. The exercises begin with the more simple forms, and extend to the most complex solids with internal cavities or hollow spaces.

Four sheets are devoted to the projections of curved lines, including the intersection of curved surfaces.

Five sheets are devoted to the projections of the lines of penetration of solids; two sheets to the development of surfaces; and three sheets to Isometric drawing. In this last a model is introduced to test the progress that has been made.

Each student is required to follow strictly the prescribed course, the problems being varied for different individuals only in the positions of the planes or form of curve. The course extends through the second half of the first year, and is obligatory upon all.

For the second year an additional course in continuation of the first is provided for those who intend to pursue the profession of Civil or of Dynamic Engineering, or of Architecture, and is obligatory only upon these. This course embraces eighteen plates or sheets, one of which is devoted to the construction, by projection, of screws, springs, and nuts; three to propeller blades; two to spur-gearing; three to bevel gearing; one to the construction of various helical and cycloidal curves; two to teeth of wheels; one to cams; and five to projection of shadows and shading with the brush.

After this follows a course of perspective based on projections, a course devised by Mr. F. R. Honey, Instructor of Drawing in the Sheffield Scientific School. In this new method of perspective, every object is first given by its horizontal and vertical projections. The point of sight and all lines of sight are projected on the same planes. The picture plane, always in front of the object, is then introduced, cutting the planes or surfaces of sight, and the intersection of the plane with the visual surfaces is found by projections. A course of graphical instruction in warped surfaces, including all the more difficult problems of Descriptive Geometry, completes the system.

It will be seen that this course embraces two full years for students of Engineering and Architecture, before they are allowed to apply the knowledge gained to composite structures in their

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own professional line. But with this preliminary training the student is prepared to enter upon the application of the principles he has learned to the special art or profession which he is to follow. The third year is devoted to this kind of drawing, but the student is no longer under a drawing-master, but under the instructor in the particular course he has chosen. The special principles of another art or profession are now the main objects to be pursued, the drawing being only a means to an end. This final course is not, therefore, to be considered as a part of the course of drawing, but a course of special study and practice in composition and design. Models are now introduced, but they are not models taken up at random, but such as illustrate certain principles of construction. The Civil Engineer takes measurements of some well-constructed bridge, or describes and illustrates by drawings of his own the various methods of making the foundations and superstructure of some public building or other Engineering work; while the Architect, following a similar course, may be prepared to extend his studies to the preparation of designs. Students of Dynamic Engineering require models illustrating the construction of joints or movable pieces, pillow-blocks, steps, and other bearings or typical parts of machinery, the models being accurately made to a scale, and in conformity with the best practice. The construction of foundry patterns is also introduced, until finally the complete construction of an engine, or furnace, or water-wheel, becomes a natural and simple process. It is in this final practice that the principles of mechanics, the strength and qualities of materials, the laws of motion and force, and the general principles of artistic design are brought into requisition.

Alterations in Sheffield Hall, and Enlargement of the Laboratories.

During previous years the limited extent of the accommodations at the disposal of the Governing Board has been felt in nothing more seriously than in the section of Chemistry, and the sciences depending upon it. With increasing classes the deficiencies in this respect were becoming each year more noticeable; and the completion of the new building came just in time, not only to relieve the pressure upon the already crowded accommodations of this department, but to furnish additional facilities which, though long needed and demanded, could not previously be given. With

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this purpose in view several of the rooms in the old building were during the summer vacation altered and refitted. In particular, the large lecture room in the third story was changed into a laboratory of Elementary Chemistry, with accommodations for ninety-six students, for the exclusive purpose of furnishing instruction to the members of the Freshman class. This was thoroughly equipped throughout, so as to be made entirely independent of any other laboratory. That portion of the laboratory of Analytical Chemistry which had previously been occupied by the Freshman class, was now taken possession of and applied to its proper use as a place of instruction for more advanced students. It may serve to illustrate the limited nature of the accommodations by which the growth of this section of the school has been prevented from reaching its full natural development, to state that all of the space vacated was immediately filled by the increased number of students desiring to follow this particular course. Not only this, but the additional accommodations, we regret to say, proved insufficient, and the Governing Board were under the necessity of declining several applications to work in it. It was, moreover, found necessary at the end of the first term to remove the students in Physiological Chemistry to the Chemical lecture room, that being temporarily converted into a laboratory. It is now the intention of the Governing Board to fit up an additional room, No. 13, in the second story, to be used as a laboratory of Physiological Chemistry. And in view of the fact that still further instruction will speedily be required in Organic Chemistry, it will doubtless be found necessary, as soon as the means at our disposal will permit, to take possession of the whole of the first floor of Sheffield Hall for the purpose of furnishing instruction in the various branches of this department.

Part of Room No. 18, previously used as a drawing room, has also been set off and fitted up as a laboratory for Determinative Mineralogy and Blow-pipe Analysis. During the past year instruction has been regularly given to fifty-four students in this branch.

Up to the present time there had also been a difficulty in making a full use of the large collection of maps and atlases belonging to the school, from the fact of their being no place where they could be placed and arranged so as to be consulted with facility. Part of Room No. 5 was accordingly set aside for this purpose, and in this eight cases were built for the reception of all

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maps and charts belonging to the institution. Three of these cases are each five feet high, four and a half feet wide, and three and a half feet deep. In these are sliding shelves or trays, thirty-eight by fifty-two inches, and four inches apart, for the accommodation of maps and charts in flat sheets and for relief maps. Above these are three other cases of the same width and depth, two of which have fixed shelves for the reception of smaller rolled maps, and the third for atlases. The remaining two cases, each about three feet wide and eighteen inches deep, extend from floor to ceiling, and are for the reception of larger maps mounted on rollers. The arranging and cataloguing of this collection have been begun.

An extensive addition has also been made to the shelf-capacity of the library.

Reorganization of the Select Course.

The facilities furnished by the new building not only enabled the Governing Board to add largely to the completeness of each of the separate courses, but led them to carry into execution a project long entertained for thoroughly reorganizing the course in select studies (Course h.) A committee was accordingly appointed early in the second term to take this matter into consideration, and on the 28th of March, 1874, their report was presented to the Governing Board and unanimously adopted. It was determined, while giving a general knowledge of the elements of several sciences, to make one science in particular more prominent than the rest; and Geology, as involving to a greater or less extent the study of several, was selected. The course is arranged in conformity with the following plan. Two terms of Junior year are devoted to Descriptive Mineralogy and Blow-pipe Analysis; and during the same two terms Physical Geography and Astronomy are also studied. The third term Zoölogy and Botany are begun, the study of both being accompanied with excursions. Zoölogy also extends through the first two terms of Senior year, and during the last term Meteorology. With the beginning of this same year Geology is begun, and continues without intermission through the third term, accompanied at proper seasons of the year with excursions. It is hoped by this course not simply to give to students a more or less complete knowledge of the elements of these sciences, but to fit those who desire to become

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specialists in Geology, or any one of the sciences more closely allied to it, to enter upon their graduate studies with a respectable amount of suitable preparatory knowledge. The general studies previously pursued by the Select Course, such as French, German, Linguistics, History, Political Economy, and English Literature, will continue to be pursued as heretofore. This change in the course takes place at the beginning of the next Academic year. But one result of the reorganization is the continuation of the study of German through the third term of Junior year for the whole class, and the arrangement in regard to this particular study went into effect this year.

Addition to the Corps of Permanent Instructors.

At the meeting of the Corporation in June, 1873, Mr. John E. Clark, who had for the past year been instructor in the school, was elected to the Professorship of Mathematics, at the request of the Governing Board. Prof. Clark was graduated at the University of Michigan in 1856, and subsequently had been a professor of mathematics in that institution and in Antioch College, Ohio. At the time of his first becoming connected with the Scientific School, he was attached to the Government Survey of the Northwestern Boundary.

The Library.

Among the most important gifts which have been made to the Library during the year are two large volumes of plates of the sections of the several lines of railways in Ireland, executed under the direction of the Irish Railway Commission; and one large volume of maps and plates of the United States Lighthouses; both of which were the gifts of Prof. John F. Weir of the Yale School of Fine Arts. Besides these, the Library has received two volumes of the Geological Survey of Ohio from Mr. Charles P. Taft of Cincinnati, and a number of important official works from Prof. F. A. Walker.

The accession of books by purchase has been comparatively small, the income being in a great measure exhausted by the subscription to the current scientific periodicals, and the expense of binding back volumes of them which have been for years accumulating. In spite of the large number of periodicals taken, the professors in the school have been and are under the necessity of

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supplementing them by subscription to the journals especially needed in their several departments, which the Library fund has not been large enough to furnish. These, though the present property of the professors, are mainly kept in the building and are always accessible for consultation.

The number of books having increased considerably during the past two years, it was found necessary to increase still further the accommodations for receiving them. During the summer vacation, accordingly, an additional number of shelves was added, capable of containing about three thousand volumes.

Instruction in the Use of the Plane Table.

The Superintendent of the Coast Survey, Prof. Pierce, having again given permission to the assistant in charge of the survey of the region about New Haven, Mr. Richard Meade Bache, to furnish instruction in the use of the plane table and in field work, a class was formed for this purpose from the students of the Scientific School. The summer vacation was spent by them in this study. Mr. Bache has courteously furnished the Governing Board with a report of the result of the instruction, in which he expresses his thorough satisfaction with the work done, and the zeal and ability displayed by the members of the party, and also states that whenever practicable he has employed graduates or undergraduates of the Scientific School in the surveys of this region as the best *personnel* at his disposal. From Mr. Bache's report it appears that the first week in July was devoted to placing signals; the plane table work then began, and was finished on the 6th of September. In this time the survey of Oyster Point, with the exception of the levelling, was executed upon the scale of $\frac{1}{1200}$, each member of the party in turn using the instrument. The statistics of the work are:

Area,	201.8 acres.
Principal shore lines,	3.39 miles.
Shore lines of creeks, ditches,	2.18 miles.

The map executed in ink by Mr. N. B. Craig, who from the first was employed by the Coast Survey, was contributed to the Harbor Commission.

Contributions to the Study of the New Haven Region.

For the sake of enabling the Governing Board to add still further to the geographical data of this region contained in their

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Seventh Annual Report, Mr. Bache has also kindly furnished the following list of positions and distances, determined (with the exception of East and West Rocks) under his direction last summer by Mr. Horace Andrews, with a six-inch Gambey theodolite, reading to 5″, by 374 sets of angles of six repetitions each.

(*a.*) *Geographical Positions in the Vicinity of New Haven, Conn.*

Name of Station.	Latitude.			Longitude.		
	°	′	″	°	′	″
East Rock,	41	19	40.046	72	54	06.033
West Rock,	41	19	54.034	72	57	21.743
Bigelow's Chimney, Fair Haven,	41	18	07.230	72	53	43.926
South Church, near Oyster Point,	41	17	51.081	72	55	32.613
Forbes' Signal, east end Tomlinson's Br.,	41	17	45.003	72	53	47.110
Oyster Point Signal,	41	16	56.060	72	55	28.711
Custom House Square Flag-pole,	41	18	00.420	72	55	06.351
Car Shop small Chimney (north),	41	17	39.133	72	55	17.197
Long Wharf Light House,	41	17	31.416	72	54	36.207
Canal Dock Signal, white top derrick,	41	17	35.905	72	54	32.442
First Congregat'l Church, Fair Haven,	41	18	32.387	72	53	17.856
Fair Haven School House Cupola,	41	18	32.793	72	53	06.023
Baldwin's Cupola, east of Quinnipiac,	41	17	40.243	72	53	21.778
Water Signal (in water near Oyster Pt.),	41	17	17.591	72	55	20.062
Rogers, Smith & Co's Cupola, knob on top,	41	18	07.066	72	54	18.471
Sargent's Cupola, flag-pole,	41	18	01.335	72	54	26.748
St. Patrick's Church,	41	18	28.324	72	54	22.128
Grace Church, Fair Haven,	41	18	23.103	72	53	36.792
Telegraph Pole Signal on Oyster Point,	41	17	07.514	72	55	32.322
Bridge Signal, R. R. Bridge, Oyster Pt.,	41	17	30.885	72	55	38.915
Dike Signal, West River Bridge,	41	16	59.576	72	55	56.278
Fair Haven Baptist Church,	41	18	31.111	72	53	03.529
Lancraft's Cupola, east of Quinnipiac,	41	18	02.757	72	52	57.389

(*b.*) *Distance between Triangulation Points within the New Haven Region.*

		Feet.
East Rock to	West Rock,	14,995.82
"	Bigelow's Chimney,	9,543.11
"	South Church,	12,854.47
"	Forbes' Signal,	11,731.35
"	Custom House Square Flag-pole,	11,082.68
"	Car Shop Chimney,	13.386.94
"	Long Wharf Light House,	13,219.23
"	Canal Dock Signal,	12,723.54
"	First Congregational Church,	7,771.21
"	Baldwin's Cupola,	12,585.36
"	Rogers, Smith & Co's Cupola,	9,457.21
"	Sargent's Cupola,	10,113.66
"	Grace Church,	8,099.90
"	Telegraph Pole Signal,	16,781.76
"	Bridge Signal,	14,868.66
"	Lancraft's Cupola,	11,151.94
West Rock to	South Church,	14,971.68
"	Forbes' Signal,	20,945.01
"	Custom House Square Flag-pole,	15,456.45
"	Long Wharf Light House,	19,179.07
"	Canal Dock Signal,	19,033.36
"	Fair Haven School House Cupola,	21,170.72
"	Rogers, Smith & Co's Cupola,	17,683.53

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		Feet.
West Rock to	Sargent's Cupola,	17,559.52
"	Telegraph Pole Signal,	18,763.44
"	Bridge Signal,	16,474.77
"	Fair Haven Baptist Church,	21,412.48
South Church to	Bigelow's Chimney,	8,453.93
"	Forbes' Signal,	8,075.27
"	Oyster Point Signal,	5,575.98
"	Fair Haven Baptist Church,	12,077.54
"	First Congregational Church, Fair Haven,	11,100.62
"	Fair Haven School House Cupola,	11,956.36
"	Grace Church, Fair Haven,	9,413.94
"	Baldwin's Cupola,	10,045.34
"	Rogers, Smith & Co's Cupola,	5,884.96
"	St. Patrick's Church,	6,567.86
"	Dike Signal,	5,516.31
"	Lancraft's Cupola,	11,904.81
Forbes' Signal to	Oyster Point Signal,	9,201.71
"	Car Shop Chimney,	6,901.08
"	Water Signal,	7,617.60
"	St. Patrick's Church,	5,134.17
Oyster Point Signal to	Water Signal,	2,276.76
" "	Dike Signal,	2,134.21

Additions to the Zoological Collections.

A. E. Verrill, Curator; S. I. Smith, Assistant.

Early in the year the Zoölogical Laboratory was removed from the old Trumbull Gallery to the large and conveniently furnished room provided in North Sheffield Hall. In this room cases have been built to contain the specimens and diagrams used to illustrate the instruction in zoölogy and geology, and also a collection illustrating the fauna of New England. These collections are, as yet, only partially arranged. The number of students who have had regular instruction and practice in the laboratory during the year has varied from six to nine. Their work has been mainly in the direction of comparative anatomy.

During the summer vacation, as in the previous two years, the curator and Mr. Smith took charge of the investigation of the marine invertebrates of New England, in connection with and under the auspices of the U. S. Commissioner of Fish and Fisheries, Prof. S. F. Baird. A large party of volunteers aided in this work. Among these were Prof. W. N. Rice, Prof. H. E. Nelson, Prof. J. E. Todd, Mr. J. K. Thacher, and Mr. Franklin Benner, all of whom had previously studied in our laboratory; Dr. P. P. Carpenter, of Montreal, Mr. G. Browne Good, of Middletown, and several others. These investigations were carried on this season in Casco Bay, Maine, and adjacent waters. Very large and valuable collections of the marine animals were made, from

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all depths to about 100 fathoms, and these, like those of the previous years, have been sent here for final study and description, and a full series of the specimens is to be permanently retained in our museum. In the autumn another series of dredgings were made in the waters farther off shore, at various depths down to 142 fathoms, by Dr. A. S. Packard and Mr. Caleb Cooke, of Salem, Mass., for the U. S. Fish Commission, on the Coast Survey steamer Bache. Their collection was likewise large and valuable, and has also been sent here for study. Preliminary reports on these collections have been published by the curator in the *American Journal of Science*. During the year the curator, aided by Mr. Smith and Mr. Harger, has also completed a detailed and well illustrated Report on the invertebrata of the southern coast of New England. This has recently been published, both as a part of the first report of the U. S. Commissioner of Fish and Fisheries, and separately, with new paging. This work will greatly facilitate the study of this department of American zoölogy, which has hitherto been peculiarly difficult, and will be a great aid to our own students in zoölogy.

The most remarkable specimen received during the year consists of portions of a gigantic cuttlefish (? *Architeuthis dux* Steenstrup) taken on the coast of Newfoundland, and forwarded, in alcohol, by the Rev. M. Harvey. This specimen consists of one of the long tentacular arms, 24 feet in length, with the large suckers well preserved; several of the shorter arms, five or six feet long; and the head, tail, and portions of the body.

Capt. C. H. Townsend has presented a large and valuable collection of oysters from New Haven Harbor, illustrating their various stages of growth, from those one day old up to four years, and also variations depending upon their place of growth. He also gave several shells and skulls of sea-turtles; jaws of sharks, etc.

Mrs. Sarah Abraham has sent an interesting collection of shells, etc., from Natal, collected by her sons, Wm. A., Chas. E., and A. J. Abraham.

Professor Marsh presented a variety of reptiles, insects, etc., as well as many osteological specimens collected on his expedition to the Rocky Mountains.

Mr. J. F. Whiteaves has sent duplicates from his dredgings in the Gulf of Saint Lawrence.

From the Smithsonian Institution we have received a collection of skins of Sciuridæ, illustrating the monograph by Mr. J. A. Allen.

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A valuable collection of authentically named Crustacea, mostly from the Pacific and Indian Oceans, has been received from the Museum of Paris, through M. Alphonse Milne-Edwards, in exchange for a collection sent to that institution.

A collection of Crustacea and Echinoderms from the Pacific Ocean, collected by the late Wm. Harper Pease, Esq., was sent by Dr. P. P. Carpenter, in exchange.

The osteological collection has been very much increased during the year, chiefly by the numerous gifts from Professor Marsh.

Professor Dana has given a large number of pamphlets and books.

Many other additions, of less importance, have been made, which will be enumerated elsewhere.

Several collections have been sent, in exchange, to other institutions. Among these are a collection of Crustacea, sent to the University of Christiania; a collection of Crustacea, sent to the Museum of Paris; and a collection of New England marine invertebrates, sent to Mr. J. F. Whiteaves.

Additions to the Geological Collections.

O. C. Marsh, Curator; O. Haberer, Assistant.

Large additions have been made to the geological collections during the past year, the most important of which have been from the west, and mainly from the Tertiary deposits of that region. A party from the college, in charge of the curator, spent a great portion of the last summer exploring the Tertiary lake basins of Nebraska, Wyoming, Utah and Oregon, visiting also later in the season Colorado and the Cretaceous deposits of Kansas, and securing for the Museum a large collection of vertebrate fossils from these interesting localities.

Among the more important specimens obtained in this region may be mentioned a nearly perfect skull of a gigantic Rhinoceros-like animal, described and figured by the curator in the *American Journal of Science*, under the name of *Brontotherium ingens*. Very important additional remains of the *Dinocerata* were also obtained, including a perfect lower jaw, thus completing our knowledge of the dentition of these animals, and deciding many other important questions in regard to their anatomy. The first remains of Edentates yet discovered in the Tertiary of this country, several new and highly interesting species of fossil horses, together with a large number of other mammals, birds, reptiles, and fishes, were among the results of this expedition.

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A large and expensive collection, mostly of foreign vertebrate fossils, has also been obtained from Europe, including a very perfect Pterodactyl from the lithographic slates of Eichstadt, Bavaria, the first specimen discovered showing the membrane of the wings. Unfortunately, for want of room, very few of these acquisitions can, at present, be placed on exhibition.

Valuable additions to the osteological collection of this department have also been made during the year. Among these may be mentioned two skeletons of the Rocky Mountain goat, from Rev. Thomas Condon, of Oregon, several Mexican tapirs, skeleton of an aye-aye, a gorilla and a large number of other monkeys, South American rodents, and birds. Mr. G. B. Grinnell, as in former years, has rendered important aid toward increasing the collection in this department.

Many other additions have been made, both to the geological and osteological departments of the Museum, all of which will be fully acknowledged elsewhere.

Additions to the Museum of Archæology.

The collections in this department have been largely increased during the year, although no opportunity is, as yet, afforded for making them available for study. Most of the additions during the year have been from various parts of this country, illustrative of the Indian and other earlier races of the continent, and especially of the west, where large collections of great archæological and ethnological value were secured by the party in charge of the curator. Many other acquisitions will be acknowledged in the list of donations.

Additions to the Mineralogical Collections.

G. J. Brush, Curator.

Among the more noteworthy additions to the mineralogical collection are a suite of crystallized minerals from the Argentine Republic, the gift of Dr. A. Stelzner of Cordova; a grand specimen of Apophylite from the Ghauts, the gift of Dr. N. Maskelyne of the British Museum; a suite of crystallized Wulfenite found at Tecoma Mine, Utah, obtained by purchase, and a mass of crystallized barytes of 250 lbs. weight, from Cheshire, Conn., the gift of Messrs. J. Lanyon and John H. Leeds.

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Public Lectures.

The eighth annual course of lectures to mechanics and others was given during the past year in the new lecture room in North Sheffield Hall. The lecturers and their subjects are indicated in the annexed programme.

I.	Mon.,	Feb. 2.	Extinct Volcanoes of the Pacific States,	W. H. Brewer.
II.	Thurs.,	" 5.	Motion,	C. S. Lyman.
III.	Mon.,	" 9.	The Ancient Lake Basins of the Rocky Mountains,	O. C. Marsh.
IV.	Thurs.,	" 12.	Modern English,	T. R. Lounsbury.
V.	Mon.,	" 16.	Milk,	S. W. Johnson.
VI.	Thurs.,	" 19.	Sea-Weeds,	D. C. Eaton.
VII.	Mon.,	" 23.	Extinct Volcanoes of the Pacific States,	W. H. Brewer.
VIII.	Thurs.,	" 26.	Strength and Elasticity of Materials,	W. A. Norton.
IX.	Mon.	March 2.	Results of the Investigations of the U. S. Fish Commission,	A. E. Verrill.
X.	Thurs.,	" 5.	Steel,	G. J. Brush.
XI.	Mon.,	" 9.	The Story of Biela's Comet,	H. A. Newton.
XII.	Thurs.,	" 12.	Common Sense,	President Porter.
XIII.	Mon.,	" 16.	Animal Mechanics,	W.P.Trowbridge.
XIV.	Thurs.,	" 19.	Pictures out of the Census,	F. A. Walker.

Necessity for Increased Endowments.

The Governing Board are again under the necessity of reminding the friends of the institution of the need of increased endowments if its efficiency is to be maintained. In spite of additions to the requirements in preparatory studies, the number of applicants for admission every year steadily increases; every year the pressure upon the limited resources of the school becomes heavier and heavier; every year the duties devolving upon its instructors assume a more burdensome character. Gratifying as it necessarily is to the members of the Governing Board to find the school steadily growing in numbers and reputation, they can not shut their eyes to the fact that its efficiency may to a greater or less extent be impaired by its very success, unless help is furnished from outside sources. The fees received from an increased number of students are utterly inadequate to pay for the expense of procuring additional instructors; and no satisfactory instruction can be given by men whose time and energies are so absorbed in the teaching of large numbers, that they are unable to keep up with the progress of knowledge and investigation in the special callings which they have chosen. Buildings, and collections, and apparatus are absolutely essential to the success of a school of

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science; its progress will be checked, if not entirely prevented, if these are not provided; but after all, it must not be forgotten that the true strength of every institution lies in the efficiency and ability of its teaching force and the character of the instruction which is imparted. It is to the desirability of strengthening the school in this respect that the attention of the friends of the institution is specially called. There are several departments in which it is of the first importance that fuller instruction should be provided. The foundation of several new professorships is urgently demanded. And the necessity is the more urgent because in some of these instances persons fully fitted to fill the positions are known to the Governing Board, and can be now secured; in the necessarily great scarcity of such material, no school can safely let slip opportunities for the acquisition of thoroughly competent men. In no quarter can gifts to the institution be made more advantageously than by the endowment of new chairs, or by contributions to the permanent fund of the institution which will enable the Governing Board to provide for additional instruction in every department, where fuller instruction is demanded.

Gifts to the Institution.

In addition to a large number of maps and atlases, and a portfolio of plates previously presented but unacknowledged, the School has received from President D. C. Gilman, of the University of California, a model, executed by Prof. J. D. Whitney, of the mountain in the Yosemite Valley, known as the Half Dome. To the same source we are also indebted for the mounting and framing of twelve large photographs of California scenery, which were presented to this institution by Mr. C. C. Watkins, the artist.

Anniversary.

The anniversary exercises were held in North Sheffield Hall on the evening of Monday, June 23, 1873. Eight theses were selected for public reading.

The candidates for degrees, with the subjects of their theses, are given in the following schedule. Those marked with an asterisk were read in the evening.

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CANDIDATES FOR DEGREES,

WITH THE SUBJECTS OF THEIR GRADUATING THESES.

DOCTORS OF PHILOSOPHY. (2)

AUGUSTUS JAY DUBOIS, C.E., *New Haven.* A general Discussion of Strains in Girders.

CHARLES SHELDON HASTINGS, Ph.B., *Hartford.* On Telescopic Eye-pieces.

CIVIL ENGINEERS. (2)

GEORGE BENJAMIN CRITTENDEN, Ph.B., *New Haven.* Design for a Mansard Roof Truss.

HARRISON WHEELER LINDSLEY, Ph.B., *New Haven.* Design of a Bowstring-Girder Drawbridge.

DYNAMIC ENGINEERS. (2)

JOSEPH FREDERIC KLEIN, Ph.B., *New Haven.* On the Economical Use of Steam.

THOMAS WILLIAM MATHER, Ph.B., *New Haven.* Design for a Boat Engine.

BACHELORS OF PHILOSOPHY. (28)

JOHN WINTHROP AUCHINCLOSS (Select), *New York City.* On the Railroad Interests of the United States.

EDGAR HENRY SUMMERFIELD BAILEY (Chemistry), *Middlefield.* On the Minerals Constituting a Rock from Litchfield, Me.

ALVAH WEED BROWN (Civil Engineering), *Englewood, N. J.* On Steel versus Iron Rails.

MOSES BULKLEY (Select), *Brooklyn, N. Y.* On the Development of Trial by Jury.

*WILLIAM RICHTER COMINGS (Dynamic Engineering), *New Britain.* On Steam Boilers and their Construction.

FILLMORE COGSWELL (Civil Engineering), *Marble Dale.* On Narrow Gauge Railroads.

WILLIAM ALLEN COWLES (Civil Engineering), *New Haven.* On the N. Y. and N. H. R. R. Bridge over the Housatonic River.

*CHARLES ADAMS CRAGIN (Dynamic Engineering), *Wallingford.* On the Silk Manufactures of the United States.

*NEVILLE B. CRAIG, B.A. (Civil Engineering), *Pittsburg, Pa.* On the Railway Bridge over the Connecticut River at Middletown.

ROBERT JOHN CURREY (Select), *San Francisco, Cal.* On some of the Influences of Chinese Immigration in the United States.

FRANCIS URQUHART DOWNING, B.A. (Dynamic Engineering), *New Haven.* On the Coal Supply of the United States.

HARRY TAYLOR GAUSE (Select), *Wilmington, Del.* On the Rise and Development of the Freedom of the Press.

*EDWARD JULIUS HALL (Dynamic Engineering), *Buffalo, N. Y.* On the Transmission of Power by Compressed Air.

HENRY SHEAFF HOYT (Select), *Staatsburg, N. Y.* On the Mound Builders of America.

*ROBERT JAFFRAY (Select), *New York City.* On English Society in the XIVth Century, as Illustrated in the Writings of Langland and Chaucer.

WILLIAM HAMPDEN JENKS (Dynamic Engineering), *Brookville, Pa.* On the Steam Engine Indicator.

GEORGE CHRISTOPHER MOORE (Dynamic Engineering), *Birmingham.* On Fly-Wheels.

WILLIAM JOSIAH PARKS (Select), *Brooklyn, N. Y.* On some proposed Methods for the Representation of Minorities.

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BENJAMIN POMEROY (Dynamic Engineering), *Southport.* On the Use of Wave Lines in Ship Construction.

SAMUEL ROCKWELL (Civil Engineering), *Bridgehampton, N. Y.* On Cast-Iron Cylinders for Piles and Piers.

AMORY EDWARDS ROWLAND (Dynamic Engineering), *Brooklyn, N. Y.* On Steam Gauges.

EDGAR CAMP SAVAGE (Dynamic Engineering), *West Meriden.* On Valve-Gearing.

*WILLIAM LUCIEN SCAIFE (Civil Engineering), *Pittsburg, Pa.* On Fire-Proof Structures.

ALFRED LEWIS SELLERS (Dynamic Engineering), *Westchester, Pa.* On Steam Boiler Explosions.

CHARLES THOMPSON SMITH (Civil Engineering), *New York City.* On the Beach Pneumatic Tunnel.

LEWIS RODNEY TAYLOR (Civil Engineering), *Hamilton, Va.* On Wire-Rope Tramways.

*EDWARD ALLEN WILSON, B.A. (Civil Engineering), *St. Louis, Mo.* On Artificial Building Stone.

*HENRY GOODRICH WOLCOTT (Select), *Fishkill, N. Y.* On the Transit of Venus.

PRIZES.

The following prizes were announced at the anniversary.

CLASS OF 1873.

For excellence in German, the prize awarded to WILLIAM L. SCAIFE, *Pittsburg, Pa.*

For excellence in French, the prize awarded to ROBERT JAFFRAY, *New York City.*

For excellence in Civil Engineering, the prize awarded to WILLIAM L. SCAIFE, *Pittsburg, Pa.*

CLASS OF 1874.

For excellence in the Mathematics of Junior Year, the prize divided between ALLEN B. HOWE, *Troy, N. Y.*, and CHARLES J. MORSE, *Poland, O.*

CLASS OF 1875.

For excellence in all the studies of Freshman Year, the prize awarded to WILLIAM A. PRATT, *New Haven;* with honorable mention of GEORGE R. KLEEBERGER, *Apple River, Ill.*

For excellence in German, the prize awarded to CHARLES W. FENN, *Portland, Me.;* with honorable mention of GEORGE R. KLEEBERGER, *Apple River, Ill.*

For excellence in Mathematics, the prize awarded to CHARLES HILDEBRAND, *New Haven.*

For excellence in Physics, the prize awarded to GEORGE L. BROWNELL, *East Haddam.*

For excellence in Mechanical Drawing, the prize divided between JOHN G. BRAMLEY, *Bovina, N. Y.*, and WILLIAM A. PRATT, *New Haven;* with honorable mention of FRANK T. CHAMBERS, *Wilmington, Del.*

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PROGRAMME OF STUDIES,

AND

CATALOGUE,

For the College Year 1873--74.

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CALENDAR.

1873.		
11 Sept.	Thursday,	First Term begins.
19 Dec.	Friday,	First Term ends.
1874.		**Winter Vacation of Two Weeks.**
3 Jan.	Saturday,	Second Term begins.
2 April,	Thursday,	Second Term ends.
		Spring Vacation of Two Weeks.
16 April,	Thursday,	Third Term begins.
23 June,	Tuesday,	Meeting of Appointing Board.
23 June,	Tuesday,	Anniversary.
25 June,	Thursday,	Commencement.
26, 27 June,	Friday, Sat.,	Examination for Admission.
		Summer Vacation of Eleven Weeks.
8, 9 Sept.	Tues., Wed.,	Examination for Admission.
10 Sept.	Thursday,	First Term begins.
17 Dec.	Thursday,	First Term ends.

ABBREVIATIONS.

S. H. - - - - - Sheffield Hall.
N. S. H. - - - - North Sheffield Hall.
TR. - - - - - Treasury Building.
D. - - - - - Durfee College.
F. - - - - - - Farnam College.
S. M. - - - - - South Middle College.
D. H. - - - - - Divinity Hall.

In the buildings belonging to the Sheffield Scientific School, the rooms numbered from 1 to 21 are in Sheffield Hall: from 26 to 58 in North Sheffield Hall.

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Corporation of Yale College.

The Governor and Lieutenant-Governor of the State are *ex-officio* members of the Corporation.

PRESIDENT.

REV. NOAH PORTER, D.D., LL.D.

FELLOWS.

HIS EXCELLENCY CHARLES R. INGERSOLL, B.A., NEW HAVEN.
HIS HONOR GEORGE G. SILL, M.A., HARTFORD.
REV. LEONARD BACON, D.D., LL.D., NEW HAVEN.
REV. THEODORE D. WOOLSEY, D.D., LL.D., NEW HAVEN.
REV. HIRAM P. ARMS, D.D., NORWICH TOWN.
REV. GEORGE J. TILLOTSON, M.A., HAMPTON.
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TREASURER.

HENRY C. KINGSLEY, M.A.

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APPOINTED BY THE CORPORATION OF YALE COLLEGE.

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REV. NOAH PORTER, D.D., LL.D. (7 TR.) 31 Hillhouse av

Chairman and Executive Officer.

GEORGE J. BRUSH, (3 S. H.) 14 Trumbull st.

Professors.

ARRANGED IN THE ORDER OF THEIR GRADUATION.

WILLIAM A. NORTON,
Civil Engineering. (34 N. S. H.) 72 Prospect st.

CHESTER S. LYMAN,
Physics and Astronomy, Theoretical and Practical. (39 N. S. H.) 88 Trumbull st.

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Linguistics and French. (205 D.) 246 Church st.

WILLIAM P. TROWBRIDGE,
Dynamic Engineering (HIGGIN *Professor*). (45 N. S. H.) 82 Prospect st.

GEORGE J. BRUSH,
Mineralogy. 14 Trumbull st.

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Agricultural and Analytical Chemistry. (12 S. H.) 54 Trumbull st.

WILLIAM H. BREWER,
Agriculture (NORTON *Professor*). (4 S. H.) 246 Orange st.

JOHN E. CLARK,
Mathematics. (56 N. S. H.) 45 Clark st.

DANIEL C. EATON,
Botany. (41 N. S. H.) Sachem st., c. Prospect.

THOMAS R. LOUNSBURY,
English. (6 S. H.) 22 Lincoln st.

OTHNIEL C. MARSH,
Palæontology. (4 TR.) 9 College st.

FRANCIS A. WALKER,
Political Economy and History. (40 N. S. H.) 30 Trumbull st.

OSCAR D. ALLEN,
Metallurgy and Analytical Chemistry. (13 S. H.) 189 Temple st.

ADDISON E. VERRILL,
Zoölogy and Geology. (42 N. S. H.) 148 College st.

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ADDITIONAL TO THE GOVERNING BOARD.

BRIG. GEN. A. VON STEINWEHR, U. S. V.
Lecturer on Military Science.

ALBERT S. WHEELER,
German. 710 Chapel st.

MARK BAILEY,
Elocution. (150 F.) 185 Temple st.

JOHN H. NIEMEYER, Professor in the Yale School of the Fine Arts,
Free Hand Drawing. 8 Art Building.

FREDERIC R. HONEY,
Descriptive Geometry and Projection Drawing. 55 N. S. H.

SIDNEY I. SMITH,
Zoölogy. (42 N. S. H.) 148 College st.

DANIEL H. WELLS,
Mathematics. 99 Bradley st.

OSCAR HARGER,
Palæontology. (4 TR.) 42 S. M.

JOSEPH J. SKINNER,
Civil Engineering. 58 N. S. H.

AUGUST H. EDGREN,
French. 189 George st.

HENRY A. HAZEN,
Drawing. 28 Ward st.

THEOPHIL M. PRUDDEN,
Chemistry. 14 S. H.

GEORGE W. HAWES,
Mineralogy. 14 S. H.

EDGAR C. SAVAGE,
Mechanical Drawing. 46 N. S. H.

SAMUEL T. TYSON,
Analytical Chemistry. 14 S. H.

BY AUTHORITY OF THE SUPERINTENDENT OF THE SURVEY.

RICHARD M. BACHE, of the U. S. Coast Survey,
The Use of the Plane Table. 82 Wall st.

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GRADUATE STUDENTS.

Jacob Jackson Abbott, PH.B.	*New Haven,*	29 Prospect st.
Philip Henry Adee, B.A.	*Westchester, N. Y.*	6 Library st.
Henry Prentiss Armsby, Worcester Free Ind. Institute.	*Millbury, Mass.*	172 George st.
Leonard S. Austin, PH.B.	*Stratford,*	Stratford.
Edgar Henry Summerfield Bailey, PH.B.	*Middlefield,*	46 N. S. H.
Alexander H. Bezjian, Prof. of Physical Science in the Central Turkey College,	*Aintab, Syria,*	120 College st.
Alvah Weed Brown, PH.B.	*Englewood, N. J.*	134 College st.
Fillmore Cogswell, PH.B.	*Marble Dale,*	136 College st.
William Righter Comings, PH.B.	*New Britain,*	187 Temple st.
William Allen Cowles, PH.B.	*New Haven,*	19 Park st.
Neville B. Craig, B.A., PH.B.	*Pittsburgh, Pa.*	33 Prospect st.
Francis Urquhart Downing, B.A., PH.B.	*New Haven,*	83 Olive st.
Charles Benjamin Dudley, B.A.	*New Haven,*	16 S. H.
James Ridgway Gawthrop, PH.B.	*Northbrook, Pa.*	27 Mansfield st.
George B. Grinnell, B.A.	*New York City,*	6 Library st.
Oscar Harger, M.A.	*New Haven,*	42 S. M.
George Wesson Hawes, PH.B.	*Boston, Mass.*	14 S. H.
Henry Allen Hazen, B.A. Dartmouth College,	*New Haven,*	28 Ward st.
John Oxenbridge Heald, B.A.	*Orange, N. J.*	6 Library st.
William Hale Herrick, B.A. Williams College,	*W. Charleston, Vt.*	47 N. S. H.
Frederick H. Hoadley, B.A.	*New Haven,*	179 Church st.
Henry Sheaff Hoyt, PH.B.	*Staatsburgh, N. Y.*	488 Chapel st.
Edward Hopkins Jenkins, B.A.	*Falmouth, Mass.*	47 N. S. H.
William Hampden Jenks, PH.B.	*Brookville, Pa.*	22 York sq.
Joseph Taplin Lovewell, B.A.	*Whitewater, Wisc.*	34 Prospect st.
Frank Oscar Maxson, PH.B.	*San Francisco, Cal.*	8 Lock st.
John Beale Mills, B.A.	*New Haven,*	42 Elm st.
Samuel Roseburgh Morrow, B.A.	*New Haven,*	153 F.
Charles Theodore Morse, PH.B.	*New Haven,*	151 York st.
Daniel Hobart Pierpont, PH.B.	*North Haven,*	145 Olive st.
Theophil Mitchell Prudden, PH.B.	*New Haven,*	14 S. H.
Edgar Camp Savage, PH.B.	*West Meriden,*	46 N. S. H.

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William Lucien Scaife, PH.B.	*Pittsburgh, Pa.*	6 Lock st.
George Henry Seyms, B.A. Trinity College,	*Hartford,*	90 Grove st.
Joseph John Skinner, PH.B.	*New Haven,*	58 N. S. H.
Henry Pease Starbuck, B.A. Harvard University,	*Nantucket, Mass.*	42 York sq. pl.
James Henry Webb, B.S. Mass. Agric. College,	*Hamden,*	Hamden.
Henry Goodrich Wolcott, PH.B.	*Fishkill, N. Y.*	134 College st.
William Curtis Wood, M.A.	*New Haven,*	102 N.
Andrew Harvey Young, B.A. Hanover College,	*Hanover, Ind.*	170 George st.

GRADUATES, 40.

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UNDERGRADUATE STUDENTS.

SENIOR CLASS.

Nathan Edward Beckwith,	*New Haven,*	64 Whitney av.
Moses Taylor Belcher,	*Garrison's, N. Y.*	55 Trumbull st.
Charles Cook Brewster,	*Norwich,*	55 Trumbull st.
Edward Brush,	*Greenwich,*	25 Prospect st.
Arthur Bucklin Claflin,	*Boston, Mass.*	159 Temple st.
Franklin Edwards,	*Northampton, Mass.*	84 Wall st.
Charles Howard Fitch,	*New Haven,*	58 Olive st.
Edwin Horace Forbes,	*Cromwell,*	125 Dwight st.
LeRoy Gale,	*New York City,*	87 Trumbull st.
Jacob Houtz Grove,	*Fredericksburg, Pa.*	23 Prospect st.
Vincent Gilpin Hazard,	*West Chester, Pa.*	35 High st.
Frazier Davenport Head,	*St. Paul, Minn.*	94 Grove st.
Frank Leroy Holt,	*Rockville,*	105 Park st.
Allen Brewer Howe,	*Troy, N. Y.*	134 College st.
Henry Hun,	*Albany, N. Y.*	23 Prospect st.
Lorenzo M. Johnson,	*Rochester, Mass.*	23 Prospect st.
Henry Jarvis Kellogg,	*Milford,*	25 Prospect st.
Charles Hittell Killinger,	*Lebanon, Pa.*	173 Temple st.
Beverly Livingston,	*New York City,*	162 York st.
William Pitt Lynde,	*Milwaukee, Wisc.*	159 Temple st.
William McGrath,	*Bridgeport,*	16 Park st.
Charles James Morse,	*Poland, O.*	46 Hillhouse av.
George Smith Needham,	*Louisville, Ky.*	420 Chapel st.
Eugene Ernest Osborn,	*Norwalk,*	147 York st.
Richard Deane Arden Parrott,	*Greenwood Works, N. Y.*	159 Chapel st.
Claudius Victor Pendleton,	*Bozrah,*	8 Lock st.
Walter Brewster Platt,	*Waterbury,*	165 Temple st.
George Coffin Power,	*Hudson, N. Y.*	83 Olive st.
William Spencer Pratt,	*New Haven,*	17 Hazel st.
William Henry Reynolds,	*New Haven,*	129 York st.
William Rockwell,	*Bridgehampton, N. Y.*	177 Temple st.
William Arthur Rogers,	*Covington, Ky.*	503 Chapel st.
John Muirhead Stewart,	*Peekskill, N. Y.*	19 Park st.
Francis Hill Stillman,	*Plainfield, N. J.*	8 Lock st.
William Richardson Upham,	*Yonkers, N. Y.*	159 Temple st.
Simeon Harrison Wagner,	*West Haven,*	106 Crown st.
John Charles Weber,	*New York City,*	165 Temple st.

SENIORS, 37.

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JUNIOR CLASS.

Charles Henry Alling,	*Birmingham*,	106 Wall st.
Caleb Dakin Barrett,	*Amenia, N. Y.*	22½ William st.
Moses Bradstreet Bradford,	*Middletown*,	21 Bradley st.
John Gilbert Bramley,	*Bovina, N. Y.*	14 Lock st.
George Loomis Brownell,	*East Haddam*,	44 York sq.
Amos Avery Browning,	*Norwich*,	8 Lock st.
Charles Stewart Bunce,	*Glastenbury*,	8 Elm st.
Algernon Taylor Burr,	*Westport*,	104 Grove st.
Frank Taylor Chambers,	*Wilmington, Del.*	122 College st.
Edward Benjamin Chandler,	*Woodstock*,	30 Dixwell av.
John Henry Chapman,	*New York City*,	46 Elm st.
William Alexander Christie,	*Newport, R. I.*	29 Prospect st.
Arthur Eugene Clarke,	*Batavia, N. Y.*	420 Chapel st.
George Rufus Cooley,	*Hamden*,	106 Crown st.
Frederic Augustus Corning,	*Hartford*,	38 High st.
Chambers McKibbin Craig,	*Alleghany City, Pa.*	33 Prospect st.
James Cunningham,	*Pittston, Pa.*	149 College st.
Charles William Fenn,	*Portland, Me.*	136 College st.
Frederic Hodgeman Foote,	*Port Henry, N. Y.*	23 Prospect st.
Charles Hamilton Fox,	*Lansingburgh, N. Y.*	116 College st.
James Freeland,	*New York City*,	92 Grove st.
Luther Henry Gager,	*Coventry*,	209 Elm st.
Robert Francis Gaylord,	*Sherman*,	Room E., D. H.
Livingston Gifford,	*Jersey City, N. J.*	191 Temple st.
Louis Emile Addison Goll,	*Newark, N. J.*	193 Temple st.
Frank Holabird Grant,	*Glastenbury*,	8 Elm st.
John Starr Griffing,	*New Haven*,	114 Chapel st.
William Cornelius Hall,	*Buffalo, N. Y.*	73 Trumbull st.
Henry Mortimer Hastings,	*Oswego, N. Y.*	193 Temple st.
Alfred Pell Haven,	*New York City*,	73 Trumbull st.
Charles Hildebrand,	*New Haven*,	16 Chestnut st.
Thomas Douglas Hoxsey,	*Paterson, N. J.*	27 Prospect st.
William Read Howe,	*Orange, N. J.*	64 Whitney av.
Julian Kennedy,	*Struthers, O.*	30 Bristol st.
Edward Austin Kent,	*Buffalo, N. Y.*	64 Whitney av.
George Reinard Kleeberger,	*Apple River, Ill.*	30 Bristol st.
Wells Cushman Lake,	*Lake Forest, Ill.*	432 Chapel st.
Charles Purdy Lindsley,	*New Haven*,	132 Olive st.

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Blanchard Lynde,	*Milwaukee, Wisc.*	191 Temple st.
Albert Sutton Macgregor,	*New York City,*	191 Temple st.
Clarence Fake McMurray,	*Lansingburgh, N. Y.*	116 College st.
Burton Mansfield,	*New Haven,*	50 Lyon st.
Charles Aldworth Maybury,	*Norwalk,*	227 Crown st.
John Charles Olmsted,	*New York City,*	189 Church st.
Edward Day Page,	*South Orange, N. J.*	11 College st.
Frederic Noah Pease,	*Ellington,*	44 York sq.
William Edward Peirce,	*Raleigh, N. C.*	72 Temple st.
Dwight Edward Pierce,	*New Haven,*	120 High st.
George White Polk,	*Odessa, Del.*	64 High st.
William Arthur Pratt,	*New Haven,*	8 Gill st.
William Shugard Righter,	*Newark, N. J.*	187 Temple st.
Walter Coe Roberts,	*New Haven,*	8 Brown st.
William Babcock Sawyer,	*Buffalo, N. Y.*	120 High st.
Richard Sharpe,	*Eckley, Pa.*	64 High st.
Clarence Hoyt Stilson,	*Cleveland, O.*	153 Crown st.
Frederick Moncrieff Turnbull,	*Hartford,*	134 College st.
George Leland Upham,	*Yonkers, N. Y.*	193 Temple st.
Thomas Alfred Vernon,	*Brooklyn, L. I.*	136 College st.
Alonzo Earl Wemple,	*Brooklyn, L. I.*	9 Library st.
William Rodman Wharton,	*Germantown, Pa.*	8 Lock st.
Alfred Newton Wheeler,	*Southford,*	59 Wooster st.
Henry Stacy Whipple,	*Birmingham,*	106 Wall st.
Edward Luther White,	*Waterbury,*	193 Temple st.
George Horace Wilcox,	*West Meriden,*	40 York sq.
Frederick Wood,	*Norwalk,*	227 Crown st.
Kenjiro Yamagawa,	*Japan,*	29 Prospect st.

JUNIORS, 66.

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FRESHMAN CLASS.

Samuel Forbes Adam,	*Canaan*,	127 College st.
Halsey Warren Allen,	*Jersey City, N. J.*	94 Grove st.
Evelyn Marcelon Andrews,	*Norwich*,	22 Trumbull st.
Benjamin Phillips Audubon,	*New Haven*,	351 Orange st.
Alvin Driggs Ayers,	*Orange*,	432 Chapel st.
Charles Eben Bacon,	*Middletown*,	125 Dwight st.
Charles Loring Brace,	*Hastings, N. Y.*	189 Church st.
James Henry Brewster,	*New Haven*,	49 Chapel st.
Frank Elwood Brown,	*West Haven*,	West Haven.
William McCulloh Brown,	*Brookline, Mass.*	143 York st.
Willis Browning,	*Norwich*,	8 Lock st.
Hermon Beardsley Butler,	*New York City*,	169 Temple st.
Walter Cleveland Butler,	*New Haven*,	113 Olive st.
Lloyd Joseph Caswell,	*Norwich*,	132 College st.
Clarence Augustus Claflin,	*Hopkinton, Mass.*	167 Temple st.
Sidney William Clark,	*Hartford*,	223 Elm st.
Jocelyn Plant Cleaveland,	*New Haven*,	140 York st.
Frank Welles Crowell,	*Brooklyn, N. Y.*	132 College st.
John Moffat Cunningham,	*Poughkeepsie, N. Y.*	149 College st.
Frederick Perkins Dewey,	*West Haven*,	West Haven.
Charles Dickinson,	*Fordham, N. Y.*	193 Temple st.
George Cornwell Dunham,	*Southington*,	66 Bradley st.
Edward Payson Farren,	*New Haven*,	35 High st.
John Sherman Fitch,	*New Haven*,	46 High st.
Edward Livingston Ford,	*Niagara Falls, N. Y.*	120 High st.
Porter Dwight Ford,	*Washington*,	66 Martin st.
Stanley Forbes,	*San Francisco, Cal.*	81 York st.
Edward Jasper Francke,	*New York City*,	7 Library st.
Robert Jackson Gibson,	*New Haven*,	44 Edwards st.
William Wesley Gibson,	*New Haven*,	44 Edwards st.
Edward Gillette,	*New Haven*,	15 Columbus st.
Charles Cortledge Godfrey,	*Southport*,	7 Library st.
Thomas Milburn Gopsill,	*Jersey City, N. J.*	143 York st.
Jack Hays Hammond,	*San Francisco, Cal.*	8 Elm st.
William Colt Harding,	*Long Meadow, Mass.*	143 Prospect st.
James Lawrence Houghteling,	*Chicago, Ill.*	167 Temple st.
Randell Hunt,	*New Orleans, La.*	132 College st.
Saburo Iwao,	*Kumamoto, Japan*,	84 Wall st.

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William Brinkerhoff Jackson,	*Belleville, N. J.*	114 Grove st.
Edward Hine Johnson,	*Jersey City, N. J.*	94 Grove st.
Clifford Pearse Johnston,	*Lake Forest, Ill.*	147 Orange st.
James Tewksbury Law,	*Tarrytown, N. Y.*	146 College st.
John Richard Lingren,	*Chicago, Ill.*	125 Dwight st.
Thomas Howard Linsley,	*West Meriden,*	121 Park st.
John Francis Luby,	*New Haven,*	21 Nash st.
Max Mailhouse,	*New Haven,*	49 Meadow st.
Howard Meyer,	*New York City,*	35 College st.
Frederick Plumb Miles,	*Salisbury,*	127 Crown st.
Hiram Allen Miller,	*New Haven,*	244 Crown st.
James Blair Murray,	*Norwich,*	132 College st.
William Mayo Newhall,	*San Francisco, Cal.*	8 Elm st.
Arthur Edward Nichols,	*Yonkers, N. Y.*	11 College st.
Miles Greenwood Nixon,	*Chicago, Ill.*	176 Temple st.
William Beach Palmer,	*Bridgeport,*	Bridgeport.
Edward Hunt Phipps,	*New Haven,*	56 Olive st.
Cyrus Polk,	*Odessa, Del.*	64 High st.
William Allen Pratt,	*Montclair, N. J.*	153 Crown st.
Nathaniel Chapin Ray,	*West Haven,*	271 Chapel st.
James Tracy Richards,	*New York City,*	120 College st.
Charles Brigham Rockwood,	*Indianapolis, Ind.*	114 Grove st.
George Trinble Rodgers,	*Brookville, Pa.*	8 Lock st.
Edward Larned Ryerson,	*Chicago, Ill.*	167 Temple st.
Andrew Gilbert Sheak,	*Binghampton, N. Y.*	81 York st.
William Atwood Shelton,	*Birmingham,*	144 Elm st.
Edward Gordon Sherman,	*Morristown, N. J.*	114 High st.
Charles David Seeberger,	*Chicago, Ill.*	147 Orange st.
Cornelius Sleight,	*Sag Harbor, N. Y.*	9 Library st.
George Watson Smith,	*Chicago, Ill.*	167 Temple st.
LeGrand Smith,	*Chicago, Ill.*	167 Temple st.
James Clifton Stone,	*Leavenworth, Kan.*	167 Temple st.
Howard Steadman Talcott,	*Hartford,*	147 York st.
George Franklin Taylor,	*Willimantic,*	38 High st.
Francis Augustus Terry,	*Lyme,*	133 Dwight st.
Allan Mason Thomas,	*Wickford, R. I.*	33 Prospect st.
Frederick William Vanderbilt,	*New York City,*	85 College st.
Charles Williams Van Vleck,	*Cincinnati, O.*	416 Chapel st.
Alfred Elisha Walker,	*Orange,*	85 Church st.
William Oakley Wallace,	*Ansonia,*	525 Chapel st.
Charles Alexander Watson,	*Hartford,*	

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David Agnew Weyer,	*Madison, Ind.*	170 George st.
David Willard Williams,	*Glastenbury,*	8 Elm st.
Thomas Yeatman,	*New Haven,*	36 Elm st.

FRESHMEN, 82.

SPECIAL STUDENTS NOT CANDIDATES FOR A DEGREE.

Launcelot Winchester Andrews,	*Springfield, Mass.*	462 Chapel st.
Charles Edwin Bogue,	*Crown Point, N. Y.*	187 George st.
Thomas Attwater Bostwick,	*New Haven,*	162 Olive st.
Charles Albert Burt,	*Wallingford,*	169 Temple st.
Russell Henry Chittenden,	*New Haven,*	23 Humphrey st.
Stephen Elijah Churchill,	*Stamford, N. Y.*	42 York sq. pl.
Samuel Fessenden Clark,	*Geneva, Ill.*	27 Prospect st.
Henry Sheldon DeForest,	*Birmingham,*	Birmingham.
Frank R. Eltzner,	*New Haven,*	201 Wooster st.
James Hall Foote,	*Cincinnati, O.*	73 Trumbull st.
Franklin Wilson Hall,	*Killingworth,*	14 Park st.
Abbott Kinney,	*Baltimore, Md.*	New Haven House.
C. G. Knox,	*Yonkers, N. Y.*	New Haven House.
Frederick Anthony Marks,	*Wallingford,*	169 Temple st.
William Henry Porter,	*Norfolk,*	125 High st.
William James Rattle,	*Cleveland, O.*	134 College st.
Charles Waterman Smith,	*Hartford,*	134 College st.
Eliphalet Gilman Storer,	*New Haven,*	6 Trumbull st.
Charles Wall Truslow,	*New York City,*	44 York sq.
Samuel Traquair Tyson,	*Philadelphia, Pa.*	14 S. H.
A. B. Waring,	*Yonkers, N. Y.*	New Haven House.
Henry Ellsworth Wood,	*Joliet, Ill.*	187 Temple st.

SPECIAL STUDENTS, 22.

SUMMARY.

GRADUATES,	40
SENIORS,	37
JUNIORS,	66
FRESHMEN,	82
SPECIAL STUDENTS,	22
TOTAL,	247

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SHEFFIELD SCIENTIFIC SCHOOL.

I.

Objects.

THE SHEFFIELD SCIENTIFIC SCHOOL is devoted to instruction and researches in the mathematical, physical, and natural sciences, with reference to the promotion and diffusion of science, and also to the preparation of young men for such pursuits as require especial proficiency in these departments of learning. It is one of the Departments of Yale College, like the law, medical, theological, and art schools, having its separate funds, buildings, teachers, and regulations, but governed by the Corporation of Yale College, which appoints the professors and confers the degrees. It is, in part, analogous to the academic department or classical college, and, in part, to the professional schools.

The instruction is intended for two classes of students:—

I. Graduates of this or of other Colleges, and other persons qualified for advanced or special scientific study.

II. Undergraduates who desire a training chiefly mathematical and scientific, in less part linguistic and literary, for higher scientific studies, or for various other occupations to which such training is suited.

II.

History and Organization.

The School was commenced in 1847. In 1860, a convenient building and a considerable endowment were given by Joseph E. Sheffield, Esq., of New Haven, whose name, at the repeated request of the Corporation of Yale College, was afterward attached to the foundation. Mr. Sheffield has frequently and munificently increased his original gifts, and during the past year, a large additional building, completely furnished throughout, was finished at his expense and presented to the School.

In 1864, by an act of the Connecticut Legislature, the national grant for the promotion of scientific education (under the congressional enactment of July, 1862) was given to this department of Yale College, which thus became "the College of Agriculture and the Mechanic Arts for Connecticut." Since that time, and especially since the autumn of 1869, numerous liberal gifts have

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been received from the citizens of New Haven, and from other gentlemen in Connecticut, New York, and St. Louis, for the endowment of the School, and the increase of its collections.

The action of the State led to the designation by law of a State Board of Visitors, consisting of the Governor, Lieutenant-Governor, three senior Senators, and the Secretary of the State Board of Education; and this Board, with the Secretary of the Scientific School, is also the Board for the appointment of students to hold the State scholarships.

At the request of the Governing Board, the Corporation of Yale College has also appointed a Board of Councillors for the School, consisting of a number of gentlemen who have taken a deep interest in its welfare, and have assiduously labored to secure its success.

The Governing Board consists of the President of Yale College and the Professors who are permanently attached to the School. There are several other instructors associated with them, a part of whom are connected with other departments of the College.

III.

Buildings and Apparatus.

The two buildings in which the work of instruction in the Scientific School is carried on are called Sheffield Hall and North Sheffield Hall. These contain a large number of recitation and lecture rooms, a hall for public assemblies and lectures, chemical and metallurgical laboratories, a photographical room, an astronomical observatory, museums, a library and reading room, besides studies for some of the professors, where their private technical libraries are kept.

The following is a summary statement of the collections belonging to the School:—

1. Laboratories and Apparatus in Chemistry, Metallurgy, Physics, Photography, and Zoölogy.
2. Metallurgical Museum of Ores, Furnace Products, etc.
3. Agricultural Museum of Soils, Fertilizers, useful and injurious insects, etc.
4. Collections in Zoölogy.
5. Astronomical Observatory, with an equatorial telescope by Clark and Sons of Cambridge, a meridian circle, etc.
6. A collection of Mechanical Apparatus, constituting the "Collier Cabinet."
7. Models in Architecture, Geometrical Drawing, Civil Engineering, Topographical Engineering, and Mechanics; diagrams adapted to public lectures; instruments for field practice.

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8. Maps and Charts, topographical, hydrographical, geological, etc.

The mineralogical cabinet of Professor Brush, the herbarium of Professor Brewer, the collection of native birds of Professor Whitney, and the astronomical instruments of Professor Lyman, are deposited in the building. Professor Eaton's herbarium, near at hand, is freely accessible.

Students are also admitted, under varying conditions, to the College and Society libraries, the College Reading Room, the Cabinet of Minerals and Fossils, the School of the Fine Arts, and the Gymnasium.

IV.

The Library.

The special technical library of the Scientific School consists of about five thousand volumes. Included in this is the "Hillhouse Mathematical Library" of twenty-four hundred volumes, collected during a long series of years by Dr. William Hillhouse, and four years ago purchased and presented to the Institution by Mr. Sheffield. A Catalogue of this collection forms a supplement to the Annual Report of the Governing Board for 1870.

The following scientific journals are received regularly at the Library, and are accessible to all for consultation.

AMERICAN.

Journal of the Franklin Institute.
Engineering and Mining Journal.
Scientific American.
Mining and Scientific Press.
Van Nostrand's Eclectic Engineering Magazine.
Railroad Gazette.
Official Gazette of the U. S. Patent Office.
Bulletin of the National Association of Wool Manufacturers.
American Chemist.
American Journal of Science.

ENGLISH.

Agricultural Gazette, The.
Annals and Magazine of Natural History.
Builder, The.
Economist, The.
Engineer, The.
Engineering.
Farmer's Magazine.
Garden, The.
Gardener's Chronicle, The.
Grevillea.
Iron.
Journal of the Anthropological Institute.

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Journal of the Chemical Society.
——— of the Iron and Steel Institute.
——— Quarterly, of Microscopical Science.
——— Quarterly, of Pure and Applied Mathematics.
——— Quarterly, of Science.
Magazine, The Botanical.
Mining Journal, The.
Monthly Notices of the Royal Astronomical Society.
Nature.
News, The Chemical, and Journal of Physical Science.
Philosophical Magazine, The London, Edinburgh, and Dublin.

FRENCH.

Annales de Chimie et de Physique.
——— Nouvelles de la Construction.
——— des Ponts et des Chaussées.
Archives de Zoölogie Experimentale et Generale.
Bulletin de la Société de Géographie.
——— de Société Chemique.
Connaisance des Temps.
Journal d'Agriculture Pratique.
——— de Zoologie.
Mémoires de la Société d'Anthropologie de Paris.
Mondes, Les.
Revue Scientifique.
——— Universelle des Mines.
Technologiste, Le.

GERMAN.

Annalen der Landwirthschaft.
——— der Physik und Chemie.
Archiv für Anthropologie.
Berichte der Deutschen Chemischen Gesellschaft.
Centralblatt Chemisches.
——— Polytechnisches.
Civil-Ingenieur, Der.
Hedwigia.
Jahrbuch, Berliner Astronomisches.
——— über die gesammten Fortschritte der Mathematik.
Journal für reine und angewandte Mathematik.
Milch-Zeitung.
Nachrichten, Astronomische.
Repertorium für Experimental-Physik, etc.
Zeitschrift für Biologie.
——— für Analytische Chemie.
——— für Math. und Naturw. Unterricht.
——— für Wissenschaftiche Zoologie.
Zeitung, Berg-und Hüttenmännische.
——— Botanische.

Niederländisches Archiv für Zoologie.

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Numerous scientific journals, not included in this list, can be found in the private libraries of various professors, which are deposited in the building, and are accessible for consultation; and in the College library there are a large number of others, especially of the proceedings of foreign academies and scientific societies.

V.

Instruction for Graduate and Special Students.

Persons who have gone through undergraduate courses of study, here or elsewhere, may avail themselves of the facilities of the School for more special professional training in the physical sciences and their applications, gaining in one, two, or three years the degree of BACHELOR OF PHILOSOPHY, or, in two additional years of Engineering study, that of CIVIL ENGINEER, or of DYNAMICAL ENGINEER.

Or, engaging in studies of a less exclusively technical character, they may become candidates for the degree of DOCTOR OF PHILOSOPHY. The instruction in such cases will be adapted to the particular needs and capacities of each student, and may be combined with that given by the graduate instructors in other departments of the University. This degree is conferred upon those who, having already taken a Bachelor's degree, engage as students in the Department of Philosophy and the Arts for not less than two years in assiduous and successful study. It is not given upon examination to those whose studies are pursued elsewhere. The requirements for it will in some cases exact of the student more than two years of post-graduate labor; so, especially, wherever the course of undergraduate study has been, as in the Scientific School, of less than four years. The candidate must pass a satisfactory final examination, and present a thesis giving evidence of high attainment in the branches of knowledge to which he has attended. A good knowledge of Latin, German and French will be required in all cases, unless, for some exceptional reason, the candidate be excused by the Faculty. The graduating fee is ten dollars.

Subjects likely to receive special attention are suggested as follows:—

Professor NORTON will instruct in celestial mechanics and in spherical astronomy.

Professor LYMAN, in the use of meridional and other astronomical instruments, and in astronomical spectroscopy.

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Professor TROWBRIDGE, in the principles of thermodynamics, and the artificial generation, transfer, and utilization of heat as a source of power.

Professor BRUSH, in the analysis and determination of mineral species, and in descriptive mineralogy.

Professor JOHNSON, in theoretical, analytical, and agricultural chemistry.

Professor BREWER, in agriculture and forest culture, in the use of the microscope, and in physical geography.

Professor CLARK, in definite integrals, differential equations, analytical mechanics, the theory of numerical approximations, and the method of least squares.

Professor EATON, in structural and systematic botany, including the North American flora and the description of genera and species.

Professor MARSH, in palæontology and comparative osteology.

Professor WALKER, in public finance and in the statistics of industry.

Professor ALLEN, in analytical chemistry, and in metallurgy.

Professor VERRILL, and Mr. S. I. SMITH, in zoölogy and geology.

The same courses of study are open, for a longer or shorter time, to graduate students who do not desire to become candidates for a degree.

Students who have taken the degree of Bachelor of Philosophy, may obtain the degree of CIVIL or of DYNAMIC ENGINEER at the end of two academical years, by pursuing the following higher course of study and professional training.

The course of study for the degree of CIVIL ENGINEER will comprise

1. Higher Calculus. Higher Geometry. Theory of Numerical Operations.
2. Analytical Mechanics. Mechanics applied to Engineering.
3. A Course of Construction and Design. Projects.
4. Practical Astronomy, with use of instruments, computations, etc.

This course will occupy three academical terms.

To secure the requisite amount of professional knowledge and practice, the candidate will be required to furnish a comprehensive Report of the results of an examination into the existing condition of some special line of constructive art; or to present proper evidence that he has had actual charge in the field, for several months, of construction or surveying parties, or held some responsible position deemed equivalent to this.

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An elaborate design must also be submitted of some projected work of construction, based upon exact data obtained from careful surveys made by the candidate, and comprising all the requisite calculations, and the necessary detailed drawings, and accompanied by full specifications of the work to be done, and the requirements to be met by the contractor.

The fee for this degree is five dollars.

The course of study for the degree of DYNAMIC ENGINEER will comprise

1. Higher Calculus, General Theory of Equations and of Numerical Operations.
2. General Principles of Dynamics (Analytical Mechanics). Including special application of these principles to Dynamical problems.
3. Constructions of Machines. Designs.
4. Preparations of theses on special subjects in Dynamic Engineering.

During the second year candidates will be permitted to employ such a portion of their time as may be deemed advisable or necessary in the examination of engineering works and manufacturing establishments, and may also have the privilege of entering upon professional practice, provided it is done with the knowledge and consent of the Professor of Dynamic Engineering, and under such circumstances as shall appear to him to be favorable to professional progress.

An elaborate thesis on some professional subject, with an original design, or project, accompanied by proper working drawings, will be required at the end of the second year.

The fee for this degree is five dollars.

SPECIAL STUDENTS.—For the benefit of those who, being fully qualified, desire to pursue particular studies without reference to the obtaining of a degree, special or irregular students are received in most of the departments of the School; not, however, in the Select Course or in the Freshman Class.

It should be distinctly understood that these opportunities are not offered to persons who are incompetent to go on with regular courses, but are designed to aid those who, having received a sufficient preliminary education elsewhere, desire to increase their proficiency in special branches.

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VI.

Instruction for Undergraduate Students.

TERMS OF ADMISSION.—Candidates must be not less than sixteen years of age, and must bring satisfactory testimonials of moral character from their former instructors or other responsible persons.

For admission to the Freshman Class the student must pass a thorough examination in the following subjects:

English Grammar—including spelling and composition.
History of the United States.
Geography.
Latin—Six books of Cæsar's commentaries or their equivalent, and simple exercises in prose composition.

Arithmetic—including the metric system.
Algebra—Davies' Bourdon's, as far as the general theory of equations, or its equivalent.
Geometry—the nine books of Davies' Legendre or their equivalent.
Plane Trigonometry—including analytical trigonometry.

The examinations for admission take place at North Sheffield Hall, on Friday and Saturday, June 26th and 27th; and on Tuesday and Wednesday, September 8th and 9th, 1874. Opportunity for private examination may, in exceptional cases, be given at other times.

COURSES OF INSTRUCTION, occupying three years, are arranged to suit the requirements of various classes of students. The first year's work is the same for all; during the last two years the instruction is chiefly arranged in special courses.

The special courses most distinctly marked out are the following:—

(a.) In Chemistry and Metallurgy;
(b.) In Civil Engineering;
(c.) In Dynamic (or Mechanical) Engineering;
(d.) In Agriculture;
(e.) In Natural History;
(f) In studies preparatory to Medical Studies;
(g.) In studies preparatory to Mining;
(h.) In Select studies preparatory to other higher pursuits, to business, etc.

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The arrangement of the studies is indicated in the annexed scheme.

FRESHMAN YEAR.—INTRODUCTORY TO ALL THE COURSES.

FIRST TERM—*German.*—Whitney's Grammar and Reader. *English.*—Hadley's Brief History of the English Language; Exercises in Composition. *Mathematics.* Olney's University Algebra, Part III, Spherical Trigonometry. *Physics.*—Atkinson's Ganot, with experimental lectures. *Chemistry.*—Eliot and Storer's Manual; Laboratory practice. *Elementary Drawing.*—Practical Lessons in the Art School.

SECOND TERM—*Language, Physics, Chemistry, and Drawing.*—As stated above. *Mathematics.*—Peck's Analytical Geometry. *Physical Geography.*—Lectures.

THIRD TERM—*Mathematics.*—Church's Descriptive Geometry. *Botany.*—Gray's Lessons. Other studies continued. *Political Economy.*—Elementary Lectures. *Drawing.*—Orthographic Projection.

For the Junior and Senior years the students select for themselves one of the following courses:—

(a.) In CHEMISTRY AND METALLURGY.

JUNIOR YEAR.

FIRST TERM—*Theoretical and Organic Chemistry.*—Lectures. *Chemical Analysis.*—Fresenius. Use of Blow-pipe. *Laboratory Practice.*—Qualitative Analysis. Exercises in English Composition. *German. French.*

SECOND TERM—*Laboratory Practice.*—Qualitative Analysis, continued. Quantitative Analysis, begun. *Zoölogy.*—Lectures. Exercises in English Composition. *German. French.*

THIRD TERM—*Mineralogy.*—Dana's. Lectures and Practical Exercises. *Zoölogy.*—Lectures and Excursions. *Laboratory Practice.*—Quantitative Analysis, continued. Exercises in English Composition. *French*—continued.

SENIOR YEAR.

FIRST TERM—*Metallurgy. Geology.*—Dana's. Lectures and Recitations. *Zoölogy.*—Lectures. *Laboratory Practice.*—Volumetric and Organic Analysis. *Determinative Mineralogy.* Exercises in English Composition. *French*—continued.

SECOND AND THIRD TERMS—*Metallurgy.*—Lectures. *Agricultural Chemistry.*—Recitations and Lectures. *Geology.*—Dana's. *Laboratory Practice.*—Mineral Analysis and Assaying. *Determinative Mineralogy. French*—continued.

(b.) IN CIVIL ENGINEERING.

JUNIOR YEAR.

FIRST TERM—*Mathematics.*—Analytical Geometry of Three Dimensions. Church's Differential Calculus. Church's Descriptive Geometry, continued. *Surveying. Drawing.*—Mechanical Drawing. Exercises in English Composition. *French and German.*

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SECOND TERM—*Mathematics.*—Differential and Integral Calculus. *Astronomy.*—Loomis's Astronomy, with practical problems. Exercises in English Composition. *French and German.*

THIRD TERM—*Mechanics.*—Peck's Elements. *Surveying.*—Topographical. Topographical sketching in the field. *Drawing.*—Binns' Second Course of Orthographic Projections. Linear Perspective. Isometrical and Topographical Drawing. Exercises in English Composition. *French.*

SENIOR YEAR.

FIRST TERM—*Field Engineering.*—Laying out curves. Location of line of Railroad, with calculations of excavation and embankment. Henck's Field Book for Railroad Engineers. *Stone Cutting*—with graphical problems. *Mechanics.*—Mechanics applied to Engineering. *Geology.*—Dana's. *Drawing.*—Architectural. Exercises in English Composition. *French.*

SECOND TERM—*Civil Engineering.*—Mahan's. Building Materials (Lectures). Strength of Materials. Bridge Construction. *Drawing.*—Mechanical. *French.*

THIRD TERM—*Civil Engineering.*—Bridge Construction, continued. Stability of Arches and Walls. *Dynamics.*—Principles of Mechanism. Steam Engine. *Hydraulics.*—Theory of Turbines and other Water Wheels. Neville's Hydraulics. *Drawing.*—Structural.

(c.) IN MECHANICAL ENGINEERING.

JUNIOR YEAR.

Pure and Applied Mathematics.—Geometry of Machinery. Analytical Geometry of Three Dimensions. Differential and Integral Calculus. *Mechanics.*—Analytical Mechanics. *Drawing.*—Binns' Orthographic Projections. Principles of Construction. Shading and Tinting, and drawing from Patterns. *Metallurgy.* Exercises in English Composition. *French and German.*

SENIOR YEAR.

Applied Mechanics.—Strength of Materials. Theory of Machines. Theory and Construction of the Steam Engine and other prime movers. Mill work. Examination of Machinery. Mechanical Construction. Use of tools. *Drawing.*—Drawing from actual Machines. Designs of Machines. Exercises in English Composition. *French. Metallurgy.*

(d.) IN AGRICULTURE.

JUNIOR YEAR.

FIRST TERM—*Theoretical and Organic Chemistry*—Lectures. *Experimental and Analytical Chemistry*—in their Agricultural applications. Laboratory practice. *French*—begun. *German*—continued.

SECOND TERM—*Agricultural Chemistry.*—Recitations. *Experimental Chemistry.*—Laboratory practice. *French and German*—continued. *Physical Geography.*—Lectures. *Zoölogy.*—Lectures.

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THIRD TERM—*Agricultural Chemistry.*—Lectures. *Horticulture and Kitchen Gardening.*—Lectures. *Mineralogy.*—Lectures and Practical Exercises. *Zoölogy.*—Lectures. *Experimental Chemistry.*—Laboratory practice. *French*—continued. *Drawing.*—Free-hand practice. *Excursions.*—Botanical, Zoölogical, etc.

SENIOR YEAR.

FIRST TERM—*Agriculture.*—Cultivation of the Staple Crops of the Northern States. Lectures. *Agricultural Zoölogy.*—Origin and Natural History of Domestic Animals. Insects useful and injurious to Vegetation. Lectures. *Geology.*—Dana's Manual. *French*—continued. *Excursions.*—Agricultural, Zoölogical, Geological, etc.

SECOND TERM—*Agriculture.*—Stock-raising and principles of Breeding. Lectures. *English. Human Anatomy and Physiology.*—Lectures. *French*—continued.

THIRD TERM—*Rural Economy.*—History of Agriculture and Sketches of Husbandry in Foreign Countries. Adaptation of farming to soil, climate, market, and other conditions. Systems of Husbandry. Stock, sheep, grain, and mixed farming. Lectures. *Excursions.*—Agricultural, Geological, Zoölogical, and Botanical.

(e.) IN NATURAL HISTORY.

(Either Geology, Mineralogy, Zoölogy, or Botany may be made the principal study, some attention in each case being directed to the other three branches of Natural History.)

JUNIOR YEAR.

FIRST TERM—*Zoölogy.*—Daily Laboratory instruction; Zoölogical Excursions. *Botany.*—Gray's Text-Book; Use of the Microscope. *Chemistry.*—Theoretical and Organic Chemistry. *French*—begun. *German*—continued.

SECOND TERM—*Zoölogy and Palæontology.*—Laboratory practice. Lectures. *Botany.*—Lectures; Gray's Text-Book. *Physical Geography.*—Lectures and Recitations. *Chemistry.*—Laboratory practice. *French and German*—continued.

THIRD TERM—*Zoölogy and Palæontology.*—Laboratory practice. Lectures, Excursions (land and marine). *Botany.*—Excursions. Practical exercises. Gray's Manual. *Mineralogy.*—Dana's. Lectures. Practical exercises. *French*—continued. *Drawing.*—Free-hand practice.

SENIOR YEAR.

FIRST TERM—*Language.*—Whitney's Language and the Study of Language. *French.*—Selections. *Zoölogy and Palæontology.*—Laboratory Practice. Lectures. Excursions. *Botany.*—Excursions. Herbarium studies. *Geology.*—Dana's Manual. Excursions.

SECOND TERM.—*Zoölogy and Palæontology*—continued. *Botany.*—Herbarium studies. Botanical Literature. Essays in Descriptive Botany. *Geology.*—Dana's Manual. *Anatomy and Physiology.*—Academical Lectures. *French.*—Selections. *Whitney on Language*—continued.

THIRD TERM.—*Zoölogy, Botany, and Palæontology*—continued, with Excursions. *Photography.*—Practical instruction.

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Besides the regular courses of lectures on structural and systematic Zoölogy and Botany, and on special subjects, students are taught to prepare, arrange, and identify collections, to make dissections, to pursue original investigations, and to describe Genera and Species in the language of science. For these purposes, large collections in Zoölogy and Palæontology belonging to the College are available, as are also the private botanical collections of Professor Eaton.

(f.) IN PREPARATION FOR MEDICAL STUDIES.

During the Junior year, the work of this course will be chiefly under the direction of the instructors in Chemistry. Especial attention will be given to qualitative and quantitative analysis, in their physiological and medical bearings; and to the preparation and study of the organic proximate elements. In the Senior year, the work will be chiefly under the direction of the Professors of Zoölogy and Botany. Attention will be paid in Zoölogy to comparative anatomy, reproduction, embryology, the laws of hereditary descent, and human parasites; and in Botany to a general knowledge of structural and physiological Botany, and to medicinal, food-producing, and poisonous plants.

(g.) IN STUDIES PREPARATORY TO MINING.

Young men desiring to become Mining Engineers, can pursue the regular course in Civil or Mechanical Engineering, and at its close can spend a fourth year in the study of metallurgy, mineralogy, etc.

(h.) IN SELECT STUDIES PREPARATORY TO OTHER HIGHER PURSUITS, TO BUSINESS, ETC.

JUNIOR YEAR.

FIRST TERM. — *German and Political Economy* — continued. *English.* Langland's Piers Plowman *French*—begun. Lectures and Exercises in Chemistry and Mineralogy. Lectures on the Physical Geography of Europe.

SECOND TERM.—*German, French*—continued. *English.*—Chaucer. *Astronomy.*—Loomis's Astronomy, with practical problems. *Modern History.*—Recitations and Lectures.

THIRD TERM.—*French*—continued. *English.*—Shakespeare. *Mechanics.*—Peck's Elements. *Botany and Zoölogy*—Lectures and Excursions, and laboratory practice.

SENIOR YEAR.

LANGUAGE.—The study of French is continued through the year, and during the first two terms there are recitations in Whitney's Language and the Study of Language. In English, Shakespeare, Milton, Dryden, and Pope are the authors studied throughout the year, and in the order here named.

NATURAL SCIENCE.—The study of Geology is pursued by recitations, lectures, and excursions. Lectures are given in Rural Economy and the Principles of Agriculture, and also in Agricultural Chemistry. Botany is studied during the early part of the autumn term.

HISTORY, GEOGRAPHY, AND POLITICAL ECONOMY.—Lectures, Recitations, and Exercises will be continued through the year.

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Exercises in English Composition are required during the entire course from all the students. The preparation of graduating theses is among the duties of the Senior Year.

Lectures on Military Science and Tactics are annually given. Instruction in Elocution is given to all who desire it the second term of Senior year.

Drawing.

The course in drawing extends through the three years. During the first term and half of the second term of Freshman year, the students practice free-hand drawing at the Art School building, under the direction of Professor Niemeyer, of the Yale School of the Fine Arts. After the completion of the course in free-hand drawing, instruction is given by Mr. F. R. Honey, during the second half of the year, in the elementary principles of instrumental drawing, embracing the whole of Binns' first course of orthographic projections, and Descriptive Geometry as far as warped surfaces. This course is obligatory upon all.

During the Junior and Senior years, instruction in drawing is obligatory only on the students in Civil and Mechanical Engineering. In the former year the system of instruction embraces Binns' second course in orthographic projections, isometric drawing, shades and shadows, tinting, perspective, and warped surfaces. By this method all the problems in Descriptive Geometry are required to be worked out on the drawing-board instead of the black-board. The course extends through the entire year, and is under the direction of Mr. Honey.

In Senior year, students are required to apply the principles of drawing already obtained to works of construction, under the general supervision of the professors of Civil and of Dynamic Engineering.

VII.

Methods of Instruction.

The instructions of this institution are given chiefly in small class rooms, by recitations or familiar lectures, illustrated by the apparatus at the command of the various teachers. In many studies weekly excursions are made for the purpose of collecting specimens and examining natural phenomena.

In Chemistry and Metallurgy the students work several hours daily in well appointed laboratories, under the direct superintendence of the instructors, and are guided through systematic courses of quantitative and qualitative analysis, assaying, and the blow-pipe determination of minerals and ores.

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In Botany, during the summer of Junior year, exercises in analyzing and identifying plants occur two or three times a week, followed by practice in writing characters and descriptions of plants from living specimens. Students are shown also how to collect and preserve specimens for future use, several Natural Orders being especially indicated to each class for special work in collecting. In the autumn term of Senior year, the work of the summer is continued. Students are then expected to write generic as well as specific characters, and at the close of the term an essay on some one Natural Order will be required. During the second and third terms, a Herbarium of the indicated Natural Orders will be prepared and presented for exàmination at the end of the year.

In Zoölogy weekly excursions are made during the third term of Junior and first term of Senior year, in company with the instructors, for the purpose of observing the habits and making collections of marine, fresh-water, and terrestrial animals of all classes. Each student is required to prepare and present for examination a collection containing a specified number of species, and illustrating the various classes of animals. He must also be able to pass an examination upon his collection, at least to the extent of explaining the classes illustrated, and showing why particular specimens belong to their respective classes.

In Geology excursions are made for the purpose of examining geological phenomena, and seeing the rocks in place; and along with this there are frequent visits to the geological collections in company with the instructor, for the purpose of seeing larger series of fossils than can be exhibited in the class room.

In addition to the above, a course of lectures is given every winter by the professors of the school and others, on topics of popular interest.

VIII.

Tuition Charges.

The charge for tuition is $150 per year, payable $55 at the beginning of the first and of the second term, and $40 at the beginning of the third term. The special student of Chemistry has an additional charge of $70 per annum for chemicals and use of apparatus. He also supplies himself at his own expense with gas, flasks, crucibles, etc., the cost of which should not exceed $10 per term. An additional charge of $5 is annually made

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to each student for the use of the College Reading Room and Gymnasium.

IX.

Church Sittings.

Free sittings for students in this department of Yale College are provided as follows:

In the Center Church (Cong.): Pews Nos. 36 and 42, in the North Gallery.

In Trinity Church (Episc.): Pews Nos. 175 and 177, in the North Gallery.

In the First Methodist Church: Pew No. 78, at the head of the West Aisle (below).

Any of the students may occupy a sitting in these slips. Those who prefer to pay for a sitting for a year, more or less, in the churches above mentioned, or in any other church of any denomination, will be aided on application to the Secretary of the School.

Sittings in the Gallery of the College Chapel are free as heretofore to the students of this department.

X.

Degrees.

Students of this department, on the recommendation of the Governing Board, are admitted by the Corporation of Yale College to the following degrees. They are thus conferred:

1. Bachelor of Philosophy: on those who complete any of the three-year courses of study, passing all the examinations in a satisfactory manner, and presenting a graduation thesis.

The fee for graduation as Bachelor of Philosophy, including the fee for Triennial Catalogues, Commencement Dinners, etc., is ten dollars; unless the person taking the degree is also an academical graduate, when it is but five dollars.

2. Civil Engineer and Dynamic Engineer: The requirements for these degrees are stated on pages 49 and 50.

3. Doctor of Philosophy: The requirements for this degree are stated on page 48.

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XI.

Terms and Vacations.

The next academic year begins Thursday, September 10, 1874. The vacations correspond with those of the Academical Department, giving two weeks at Christmas, two weeks in the Spring, and eleven weeks in the Summer.

XII.

Announcement in Respect to State Students.

The scholarships established in this School in consequence of the bestowal upon it of the Congressional grants are designed to aid young men who are in need of pecuniary assistance in fitting themselves for agricultural and mechanical pursuits of life. All applicants must be citizens of Connecticut. In case there are more applicants than vacancies, candidates will be preferred who have lost a parent in the military or naval service of the United States, and next to these such as are most in need of pecuniary assistance: and the appointments will be distributed as far as practicable among the several counties in proportion to their population. The appointing Board for the current year, consisting of the Board of Visitors of the State and the Secretary of the School, will meet on June 23, 1874, and at about the same time in the year 1875, due notice of which will be given by publication in every county of the State. All applications should be made previous to that time. Blank forms for application will be sent, when requested, by Professor GEORGE J. BRUSH, Secretary of the Appointing Board.

XIII.

Anniversary.

The Anniversary of the School is held on Tuesday of the Commencement week in Yale College, June 23, 1874, when selections from the graduation theses are publicly read. The degrees are publicly conferred by the President and Fellows of Yale College on Commencement Day.

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TENTH

ANNUAL REPO

OF THE

SHEFFIELD SCIENTIFIC

OF

YALE COLLEG

1874–75.

PRINTED BY ORDER OF THE GENERAL

NEW HAVEN:
TUTTLE, MOREHOUSE AND TA
1875.

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State Board of Visitors.

CONSTITUTING, WITH THE SECRETARY OF THE SCHOOL, THE BOARD FOR THE APPOINTMENT OF STATE STUDENTS.

GOVERNOR.

His Exc. CHARLES R. INGERSOLL, New Haven.

LIEUTENANT-GOVERNOR.

His Honor GEORGE G. SILL, Hartford.

STATE SENATORS.

Hon. CHARLES M. POND, Hartford.
Hon. SAMUEL M. FENNER, South Woodstock.
Hon. MERRICK A. MARCY, Union.

SECRETARY OF STATE BOARD OF EDUCATION.

Rev. BIRDSEY GRANT NORTHROP, New Haven.

Councillors.

APPOINTED BY THE CORPORATION OF YALE COLLEGE.

Hon. JAMES E. ENGLISH, New Haven.
Hon. MARSHALL JEWELL, Hartford.
Hon. JOSEPH R. HAWLEY, Hartford.
Hon. OLIVER F. WINCHESTER, New Haven.
JOSEPH E. SHEFFIELD, Esq., New Haven.
Prof. JAMES D. DANA, LL.D., New Haven.
HENRY FARNAM, Esq., New Haven.
M. DWIGHT COLLIER, M.A., St. Louis.
Hon. WILLIAM E. DODGE, New York City.

SECRETARY AND TREASURER OF THE SCHOOL.

GEORGE J. BRUSH.

JANITOR OF SHEFFIELD HALL.

ANTON PFEIFER, 55 Lock street.

JANITOR OF NORTH SHEFFIELD HALL.

GEORGE W. STODDARD, 167 Columbus street.

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TENTH

ANNUAL REPORT

OF THE

SHEFFIELD SCIENTIFIC SCHOOL

OF

YALE COLLEGE,

New Haven, Conn. —

1874–75.

PRINTED BY ORDER OF THE GENERAL ASSEMBLY.

NEW HAVEN:
TUTTLE, MOREHOUSE AND TAYLOR.
1875.

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REPORT OF THE STATE BOARD OF VISITORS.

To the General Assembly of the State of Connecticut:

THE State Board of Visitors of the Sheffield Scientific School are happy to report, that though the standard of admission has been advanced, and is now high compared with other similar institutions, the whole number in attendance the present year (249) is larger than in any former year. Over one thousand students have been connected with it during the past ten years, and nearly three hundred have completed the regular course. It is one indication of the wide influence of this Department that seventy-five of its former students are now professors in science in American Colleges.

The Governing Board have generously added three gratuitous scholarships to the twenty-seven State scholarships allowed by law. These State scholarships have afforded to many sons of farmers and mechanics a free education which they could not otherwise have obtained. "Among them frequently are young men who have taken the first honors of the School, and who are now occupying positions of usefulness and trust."

In behalf of the Board,

CHARLES R. INGERSOLL,
Chairman.

BIRDSEY G. NORTHROP,
Secretary of the State Board of Education.

NEW HAVEN, May, 1875.

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ANNUAL STATEMENT

OF THE

GOVERNING BOARD.

Ten years have now passed since the Sheffield Scientific School began to enjoy the benefit of the national grant for the promotion of technical and scientific education; and in presenting their tenth Annual Report the Governing Board feel a certain pride in referring to what has been accomplished during the first decade. The number of students is now nearly three times as great as when the first report was presented, and this too in spite of the fact that the requirements for admission have been steadily increased. The collections of various kinds have received great, and in some cases enormous, additions. The accommodations of the school, chiefly through the munificent liberality of Mr. Sheffield, have kept pace in great measure with its growth. Indeed, the chief danger which now threatens the institution is that its efficiency will be impaired by its very success; that the number of students will increase faster than the limited resources of the school can provide for them the best instruction. Still, with the experience of the past ten years before their eyes; with the recollection in their minds of the sympathy and aid from numerous quarters which they have received in times of doubt and difficulty; and with the knowledge that the reputation and efficiency of the school have never been so high as now, the Governing Board enter upon the second decade with the determination to keep it, as far as lies in their power, fully up to the ideal they have in view, and with the confidence that friends of scientific education will rise up to sustain them in the future as they have in the past.

The most important event of the year, as regards the progress of science in the institution of which the Sheffield Scientific School is a part, is the erection of the Peabody Museum of Natural History. Though all departments of the university will share in the benefits accruing from this, the Scientific School, on account of the

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nature of its work, will be more materially assisted, not only by the increase of accommodations afforded by it, but by the opportunities for special study furnished by the vast collections and laboratories to be deposited within it. The building now in process of erection will, it is hoped, be completed during the present year, and full details in regard to it will be furnished in our next Annual Report.

No alterations of importance have taken place save the fitting up of room No. 13 in Sheffield Hall as a physiological laboratory; all the room in the analytical laboratory being imperatively required for its special work. The apartment is large enough for but few students, and is far from realizing what is actually needed; at the same time, in spite of its small size and limited accommodations, it has already been of good service.

National Aid to Schools of Science and Technology.

In accordance with a resolution adopted by the House of Representatives in Washington, D C., the following letter was sent in the latter part of February, 1874, to the President of this institution, and with it a schedule of inquiries in regard to the management and condition of the School.

WASHINGTON, D. C., February 18, 1874.

To Rev. NOAH PORTER, LL.D., *President of Sheffield Scientific School:*

SIR: On the second of the present month the House of Representatives unanimously adopted the following resolution:

"*Resolved*, That the Committee on Education and Labor is hereby instructed to inquire into the condition and management of the Agricultural and other Colleges which have received grants from the United States under the act of July 2, 1862, and the acts in addition thereto; also to inquire in regard to the investment and security of the funds of these institutions, and whether their management is in accordance with the Constitution and laws of the United States and the conditions of the aforesaid grants."

In the discharge of the duty thus imposed upon the Committee, we respectfully address to you the accompanying inquiries, and shall hope to receive your reply as promptly as your convenience and the preparation of the necessary information will permit.

These inquiries are addressed to you in no unfriendly spirit, but in the hope and belief that the large majority of the institutions contemplated by them have been honestly managed, and a large portion of them both honestly and wisely. We trust that the replies received will be so full, thorough, and candid as to prevent the necessity of any further measures to obtain the desired information.

This letter and the accompanying schedules will be forwarded, not only to institutions organized under the act of July 2, 1862,

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but to others of similar character and object, in the belief that the officers of the latter class will take pleasure in replying to such of the inquiries as are pertinent to their circumstances and thus furnish the means of an instructive comparison.

Yours respectfully,

JAMES MONROE,
Chairman of the Com. on Education and Labor.

Many of the inquiries contained in the schedule it was not possible for the officers of the school to answer, there being no data in their possession upon which to found a satisfactory reply, but the following statement was transmitted, on the 16th of March, 1874, to the Committee on Education and Labor, and with the documents accompanying it, is believed to furnish all the information required in regard to the most essential points indicated by the resolution of the House.

Statement regarding the Sheffield Scientific School, in response to Inquiries made by the Committee on Education and Labor of the House of Representatives.

Hon. JAMES MONROE, *Chairman of the Committee on Education and Labor:*

Sir: The Sheffield Scientific School of Yale College was, by Act of the General Assembly of Connecticut, approved June 24, 1863, designated to be the recipient of such income as might be derived from the fund obtained from the sale of land-scrip donated to the State by the National Government in the Act of Congress, approved July 2, 1862.

The laws of the State [see document A, submitted herewith] placed the control of the scrip under the charge of the State Commissioner of the School Fund, to be sold by him, on terms to be previously approved by the Governor of the State, the avails to be invested in the manner prescribed by the Act of Congress, and the income of the fund to be semi-annually paid to the President and Fellows of Yale College, to be devoted exclusively to that department of Yale College known as the Sheffield Scientific School:—the said corporation agreeing to carry out the provisions of the Act of Congress, to make an annual report, and to devote one half of the income received to free scholarships for State students. Official information regarding the sale of the scrip and the funding of the amount received therefor can only be obtained from the State authorities. It is believed to have been sold in the summer of 1864 for seventy-five cents an acre, and that $135,000 was received from the 180,000 acres given to the State. This sum was invested in United States ten-forty gold-bearing 5 per cent. bonds, but by order of the General Assembly, in 1865, this investment was changed to Connecticut State bonds, for the same amount, bearing 6 per cent. currency interest.

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Yale College is believed to have been among the first institutions in the country to recognize the importance of the kind of education contemplated in the Act of Congress of July 2, 1862.

The Corporation of this College, in August, 1846, established a professorship of Agricultural Chemistry and of Vegetable and Animal Physiology, and at the same time they also established a professorship of Practical Chemistry, for the avowed purpose of "giving instruction to graduates and others not members of the undergraduate classes, in respect to the Application of Chemistry to Agriculture, to the Manufacturing Arts, to the exploration of the resources of the country and to other practical uses."

The following professorships have since been established:

1852, Civil Engineering.
1855, Metallurgy.
1856, Analytical Chemistry.
1859, Industrial Mechanics and Physics.
1860, French and German.
1863, Physical Geography.
1864, Agriculture.
1864, Botany.
1864, Zoology.
1865, Mining.
1866, Palæontology.
1870, Dynamic Engineering.
1871, Mineralogy.
1871, English.
1872, Political Economy.
1873, Mathematics.

Besides the incumbents of these chairs, the National Government in 1866 detailed an army officer to act as professor of Military Science, and a large number of lecturers and assistant instructors have from time to time been employed: for a detailed list of these reference is made to the Annual Reports, Nos. 1–8, herewith submitted.

In 1860 this school was provided with a commodious building, by the munificence of Joseph E. Sheffield, Esq., of New Haven, and the department was subsequently named, by the Corporation, the Sheffield Scientific School of Yale College. Although the school already provided almost everything contained in the Act of July, 1862, the authorities, in 1864, in anticipation of the reception of the income from the National Grant, enlarged its faculty by the appointment of special professors of Agriculture, of Botany and of Zoology, and made provision for instruction in Military Science, which latter has been regularly given up to the present time; and it is believed that in every particular they have conscientiously endeavored to carry out the intent of the Congressional Act.

The income from the National Grant is recognized as having been of the greatest service in making effective a plan already operating fairly, but needing further pecuniary aid to ensure a more complete success. The first year (1864–65), as the fund was invested in ten-forty bonds and gold was at a great premium, the income was larger than at any subsequent period: for the past seven years it has been uniformly $8,100 per annum. For an abstract of income and expenses see table on the next page. Our books are not kept in such a way as to give the data called for in your printed list of inquiries. A full and detailed account of the contributions to the Sheffield Scientific School may be found on

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pp. 32–36 of the Seventh Annual Report, sent herewith, and lists of contributions to the collections of models and specimens are published in each Annual Report. The funds of this department are kept entirely distinct from those of other departments of the College.

	Income.				Expenses.			
Year.	National Land Grant.	Tuition Fees.	Other Sources.	Total Income.	Instruction.	Library, Apparat's, Fuel, Gas, Labor, and Sundries.	Total Expenses.	Number Students
1864–65	$13,233.05	$3,267.00	$3,577.41	$20,077.46	$11,788.50	$6,241.06	$18,029.56	82
1865–66	7,551.56	7,041.47	3,728.99	18,522.02	17,925.00	5,826.76	23,751.96	89
1866–67	8,100.00	8,840.69	5,408.61	22,349.30	19,442.00	4,226.87	23,668.87	119
1867–68	8,100.00	9,157.22	5,193.67	22,450.89	19,590.00	4,445.62	24,035.62	120
1868–69	8,100.00	8,395.00	5,955.89	22,386.63	19,655.00	4,018.07	23,683.07	132
1869–70	8,100.00	8,140.00	23,634.05	39,874.05	17,810.00	15,441.50	33,251.50	139
1870–71	8,100.00	7,527.00	15,650.04	31,277.04	27,680.00	5,813.25	33,493.25	123
1871–72	8,100.00	15,305.77	20,683.93	44,089.70	32,180.00	5,911.11	38,091.11	146
1872–73	8,100.00	19,119.47	23,016.72	50,236.19	41,737.75	6,345.59	48,083.34	201
1873–74								242

State Inspection.—By an Act of the General Assembly of the State of Connecticut, a Board of Visitors is constituted whose duty it is to inspect the school, and see that the conditions of the Congressional Act are fulfilled, and annually to make a report to the Legislature, and also to examine and determine the claims of candidates for State Scholarships. The visits of the Board of Visitors have been at least twice each year, and their reports are herewith submitted. The number of the State Scholarships allowed by law is 27, but the authorities of the school have for several years permitted 30 to be admitted, in order to allow an equitable distribution of scholarships to each of the counties in the State.

Buildings and Apparatus.—The school now occupies two large buildings, the descriptions of which in full are to be found in the Second and Eighth Annual Reports. These buildings, with fittings and the lots of land upon which they stand, were the gifts of Joseph E. Sheffield, Esq., of New Haven, and cost about $215,000. The apparatus, models, and cabinets in Agriculture, Mechanics, Physics, Astronomy, Civil and Mechanical Engineering, Metallurgy, Mining, Zoology and Botany, with the technical library numbering 5,000 volumes, are valued at $75,000; but this does not include private libraries, collections, and cabinets of the professors, freely accessible to students, which may be valued at more than $40,000 additional. The members of this department have also free access to the library of the University, as well as to the Natural History and other collections and cabinets.

Instructors and other Officers.—The number of professors, lecturers, instructors and assistants for each year since the receipt of the income from the Congressional land grant is definitely stated in each Annual Report, and for the current year, the Report not

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having yet been issued, the particulars may be found in the Programme sent herewith.

The instructors at present number 30 and with three exceptions have no connection with, and do not instruct in, any other department of the University. Their salaries are paid exclusively from the funds of this department. In this connection it may be well to remark that the President, Treasurer and Secretary of the University, whose names appear on the Programme, receive no pecuniary compensation from the funds of the school.

Students.—Over one thousand students have been connected with the school in its various sections, and some 280 have completed regular undergraduate courses connected with this department of College. The current year 242 are present: of these 37 are graduate students, 185 are in the undergraduate courses, and 20 are special students.

Section of Agriculture.—The school has always had students pursuing Agricultural studies, although the number taking the regular Agricultural course has been small. Nevertheless its teachers in Agriculture, from the foundation of this department, have wielded a powerful influence, not only in this State, but also throughout the whole country, in matters appertaining to both practical and scientific Agriculture. The names of the late Professors John P. Norton and John A. Porter, the first two occupants of the chair of Agricultural Chemistry, will be long gratefully remembered throughout New England and the Middle States for the earnest and successful endeavors they put forth to promote a sound agriculture. And the present incumbents of the chairs of Agriculture and Agricultural Chemistry are everywhere acknowledged as among the foremost men in their respective departments.

Professor Johnson has conducted researches in our laboratory of vast importance to agriculture, and his critical analyses of manures and his exposure of worthless or spurious fertilizers have been the means of saving hundreds of thousands of dollars to citizens of this State, besides, by the publication of this information, benefitting very materially the farmers of other sections of the country. Professor Johnson's volumes entitled "How Crops Grow" and "How Crops Feed" have been introduced as textbooks in many Agricultural Colleges, and other institutions where Scientific Agriculture is taught. They have not only been widely circulated in the United States, but these works have also been republished in England, and, with a highly commendatory introduction by Baron von Liebig, have been translated into German by his son, Herman von Liebig, for the benefit of German agriculturists. During the past year these books have been translated into Russian and published in St. Petersburg, for the improvement of the farmers of Russia. We have no farm.

Section of Civil and Mechanical Engineering.—In the chairs of Civil and Mechanical Engineering, the school has had the good fortune to secure as professors two eminent graduates of the

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West Point Military Academy, and under these gentlemen the institution has trained a large number of men who are occupying important positions as engineers in the survey, construction and care of railways and other public works, mines and manufacturing establishments. Draughting, designing and practical experience with instruments in the field are among the requirements in this course. We have no machine-shop for students.

Chemistry, Mineralogy and Metallurgy.—In the section of practical Chemistry, Geology, Mineralogy and Metallurgy the school has from its earliest establishment furnished analytical chemists, assayers, metallurgists, mineralogists, and geologists, who have done good service in their several callings.

Besides these the school has contributed trained men to the U. S. Coast Survey, the Hydrographic Bureau, the National Observatory, and geologists and explorers and topographers for the Government service in connection with the U. S. Engineering Department, among whom may be mentioned Clarence King, Geologist in charge of the 40th Parallel Geological and Topographical Survey, who with other members of his corps graduated here.

But perhaps the most signal service which the Sheffield Scientific School may justly claim, is the education, in whole or in part, of 75 professors in science, who are occupying positions of responsibility in connection with colleges in different parts of our land.

Special Students.—In addition to the regular courses, the advantages of the school have always been open to persons not candidates for degrees or desiring to take a complete course, but wishing to spend a longer or shorter time in the study of some particular subject. It has thus afforded an opportunity for students, specialists, and others engaged in practical affairs to perfect themselves in some branch of knowledge essential to further progress. A list of these special students for each year can be found in the programme appended to the Annual Report.

While affording a "liberal and practical education" in many different kinds of technical science, it has, however, been kept steadily in view as the leading object of this department to inculcate a love of science for its own sake, thereby to foster original research and extend the bounds of knowledge, as it is firmly believed that by this method the resources of the country will be most rapidly developed, the mechanical arts advanced and perfected, and the methods and appliances of agriculture improved.

It has been hoped and expected that no small proportion of those trained here would devote themselves to scientific investigation, and by their knowledge and skill prevent the sinking of capital in worthless schemes, expose fraudulent and ignorant efforts to deceive the public, and by the application of the principles of science so improve the processes prevailing in Agriculture and the Mechanic Arts as to benefit the whole country by benefitting the productive and laboring classes. In this hope we have not been disappointed.

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In concluding this statement, the authorities desire to express to the Honorable Committee their very grateful acknowledgments of the essential service which the income from the National Land Grant has rendered to this institution. While struggling to accomplish the very objects included in the Act of Congress, this help, proffered at a most critical period in our history, brought certainty of success where there had been doubt and rendered our plan immediately effective. This gift has also been the means of affording to many persons in this State, from the farm and the shop, a free education, which without the Government aid they never could have obtained. Among these are young men who have frequently taken the first honors of the school and are now occupying positions of usefulness and trust.

It has been found impracticable to respond in detail to the questions contained in the printed list of inquiries, and the foregoing statement is respectfully offered as being a full exhibit in regard to all points where the National Government has relations with us.

If further information regarding the character, organization and workings of the Sheffield Scientific School is desired, it will give us pleasure to send one or more of our officers to appear before you personally at such time as you may designate.

(Signed) NOAH PORTER,
President of Yale College,
For the Governing Board of the Sheffield Scientific School.

The report of the Committee was made to the House of Representatives on the 13th of January, 1875, and the facts elicited may be regarded as on the whole amply proving the wisdom of the policy which led to the enactment of the Act of July 2, 1862.

Agricultural Experiment Stations.

The subject of agricultural experiment stations having become one of great interest to the farming population of the State, and having already been brought twice before the Legislature for consideration, it was deemed expedient by the Governing Board to bring together and put into accessible form the facts necessary for the proper consideration of this question. At their request, one of their number, Prof. S. W. Johnson, accordingly prepared a full report as to the extent to which these experimental stations had been established in Europe, the objects which they had set out to accomplish, the benefit they had conferred upon agricultural industry, and in general terms the success or failure which had attended the work they had been designed to do. The details of the information thus collected Professor Johnson gave in one of the lectures of the Mechanics' Course, delivered during the past winter, and the same facts essentially have been

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repeated in lectures subsequently delivered by him in various places in the State. The following full text of Professor Johnson's report was submitted to the Governing Board, and ordered by them to be printed in their annual statement.

The Agricultural Experiment Stations of Europe.

FARMING is a perpetual trying of experiments with soils, manure and crops, with cattle and cattle food, with milk, butter and cheese, with plows, harrows, and harvesters: with an almost endless list of things. The most successful farmers—those who get the most out of their land, their cattle, their crops, their fertilizers, their implements, and their labor—are those who experiment themselves most industriously, most skillfully, and most intelligently, and who take the fullest advantage of the experiments of others. The best agriculture is that which, in old countries, on worn and intractable soils, has learned by long-continued and varied experiment to make the gain of farming so sure, that capitalists as willingly loan money to invest in farm improvements as they put it into bank or railroad stock.

To take away from our agriculture what has been learned by toilsome and costly experiment would put us all back into the dark ages, for it would annihilate a thousand industries by cutting off supplies of the raw materials they work up; it would stop our railway trains, and lay up our ships at the dock, for there would be no grain, no cotton, no fruits to transport. The country would stagnate for want of knowledge how to keep its men and women employed; the land would grow up to weeds and woods for want of implements to till it, and for want of seeds to plant. A few winters would starve our cattle, a few years would bring famine to ourselves. The cities, which have their roots in the country, would be paralyzed in every industry, in all their traffic, in all their commerce. The North would be depopulated by starvation or by emigration to snowless and frostless latitudes, and only a few hunters in winter, or herdsmen in summer, would break the solitudes of a New England desolation.

Our wealth, our enterprise, our intelligence, and our very virtue depend in large degree upon our agriculture; and our agriculture is the result of experience, and therefore depends mainly upon experiment. Agricultural experiment then, it cannot be denied, is an exceedingly weighty matter.

But as agriculture has grown in the past from small beginnings and by slow degrees until it has subdued the forests and dried up

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the morasses of nearly all Europe and much of North America, and has raised our savage and plundering German and Anglo-Saxon ancestry to such habit of doing and having, that their posterity, by sheer inheritance of character and possessions, now comprise the foremost nations of the world,—so agriculture must go on to grow, winning more acreage from forest and swamp, building more railroads and steamships, more cities and manufactories, and employing an ever-increasing force of men and women, horses, waterwheels, and engines to do its traffic, turn its useful raw products into more useful fabrics and foods, or to supply its incessant demand for more tools, machines, and fertilizers.

Our soil is a mine of infinitely more riches than all the gold veins or placers of California and Colorado. Out of it the farmer digs our food and our clothes, and that mainly sums up the wealth of most of us. This riches of the soil may be easily squandered, and much of it now is from mere ignorance as good as thrown away. It may be restored also. Unlike metallic ore, which once dug out and skillfully smelted is forever worthless, the soil has a productive power of unlimited duration. The agencies that made soil from rock in the ages past are perpetually at work making new soil from the rock of to-day, as well as developing new fertility in the ancient soil. Man "by searching" has found out various means to accelerate and intensify this restoration and elaboration of fertility, and that people among whom the quest of better, cheaper, and more energetic means of heightening the productive power of the soil, and of best economizing that already at disposal, has been most successfully prosecuted, is the people that will lead in the march of civilization, and will impress its language, its manners, and its morals on the world.

Our agriculture has two very prominent wants. The one is a more universal acquaintance with and practice of what has already been learned, and the other is the learning of many things now unknown, which we feel important to understand—the settlement of much discussed questions that vex and baffle us in laying our plans, and embarrass our practice—the discovery of new facts that shall enlarge and improve our systems of farming. Every farmer remembers that his successes have been reached by a series of discoveries on his part. He can remember when he followed this and that practice, which he has come to see are defective and injurious, and therefore has abandoned—that he was once ignorant of most useful operations, resources, and methods, which, one by one, have been revealed to him, either by conversation, reading,

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visiting some neighbor, near or remote, or by reflection and observation on his own premises.

Every New England farmer who maintains or increases the productiveness of his land under the changed circumstances of recent years has done it by using knowledge which his forefathers did not possess or did not use, and no such farmer would willingly part with the knowledge thus gained. He would not part with it because there is advantage in it, money in it. He would not part with it because it has been a pleasure to acquire, and is a pleasure to possess and to communicate, and because he feels that he himself has grown and ripened by the gain of this knowledge. It has become a part of himself, and in its assimilation he has become richer and stronger, and is happy in a greater mastery over nature, as well as in a consciousness of being abreast of the time and its opportunities.

The successful farmer is also he who most keenly feels the need of more knowledge. He has had his eyes most widely opened to the defects and insufficiency of his farming. He appreciates most keenly that, while the least cost of a crop or of an animal's keep amounts to a certain sum—whether corn and cow be good or bad—the profit lies mainly in every kernel of grain or drop of milk he can produce *as increase* above the ordinary yield. To get an increase becomes his unceasing endeavor. He tries this method and that, varies the tillage and the treatment of the crop, varies the rations and increases the care of his cows, proving all things and holding fast to that which experiment shows to be good. But with his best efforts he feels that there are blanks in his knowledge that he cannot fill. He tries a practice most highly recommended, and can get no profit of it, then another with like result, and often finds the gains of his successful trials fully offset by the costs and losses of his failures. He does not lose faith in this plan of getting knowledge, but he learns that he cannot carry out all his good ideas, cannot make all the trials he would like, and has to submit to uncertainty and disappointment. He is more sobered than inspirited by some of his ventures, and if he does not settle down in "the good old way," he inclines more thereto, and feels a more charitable sympathy for those who let their neighbors try experiments, and even for those who get on by saving and by "scrimping," rather than by learning.

Recent years have brought a marvelous increase of knowledge into the world of affairs, and have strangely intensified the search for knowledge, as well as multiplied and energized the means of dis-

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covery. The methods and the fruits of intellectual investigation, the systematic hunting down of things hidden from the common gaze, and the game thus captured, are what we call science. Science is the peculiar pride and glory of our century, for, although its seeds struck root in the old centers of Hindoo, Egyptian, Greek, Roman, and Arabian civilization, it has grown, like the Century Plant, with wearisome slowness, until, almost in our time, it has shot out its flowering stem, and is now at once unfolding a myriad blossoms and hanging full of precious fruits.

Of these benefits agriculture has had a fair share, and the results are like the transformations of magic.

It is a little more than a century ago that the wagon, the plow, and the harrow were almost the only machines used in the field processes of agriculture, and these were of rude and inefficient construction. There were almost no other implements then known for making the labor of four-footed animals of avail in farming operations. Then seeds were sown, crops weeded and tilled, harvests gathered, grain threshed and dressed almost exclusively by hard human toil.

So fixed had become the habits of the farm through long centuries of unvaried drudgery, that when Jethro Tull invented his seed-drill and horse-hoeing implements he could hardly make way for them, even by showing that they withstood the crucial test of use. It took many years to bring horse-husbandry to the level of practice, and practice to the level of horse-husbandry. But to-day we prepare the ground, sow the seed, till the plant in all stages of its growth, cut, spread, and gather the harvest, lift it upon the wagon, and lift it again into the barn loft, thresh, winnow, and bag it all by machines impelled by horse power, and only requiring a little skilled guidance and some ordinary attendance for full success.

A quotation from Eliot's "Fifth Essay on Field Husbandry," published in 1754, well illustrates by what stages and influences the machines for utilizing horse power on the farm have been gradually simplified, perfected, and cheapened so as to admit of universal use. The quotation, for which I am indebted to Professor Brewer, is as follows:

"Mr. Tull's wheat drill is a wonderful invention, but being the first invented of that kind, no wonder if it be intricate, as indeed it is, and consists of more Wheels and other Parts than there is really any Need of. This I was very sensible of all along, but

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knew not how to mend it. Therefore I applied myself to the Reverend Mr. *Clap*, President of *Yale* Colledge, and desired him, for the regard he had for the Publick and to me, that he would apply his mathematical Learning and mechanical Genius in that Affair; which he did to so good Purpose that this new modelled Drill can be made for the fourth Part of what Mr. Tull's will cost."

A century ago the hard labor of a man could cut, rake and bind, thresh, and clean at the rate of but seven bushels of wheat per day, and there was no other practicable way known of doing the greater part of this necessary work. Now, a day's work of a man, attending our improved machines, can harvest and prepare for market fifty bushels.

Half a century ago two men and five horses, working in the most approved manner of those days, could comfortably thresh, and clean, and get away the straw of 108 bushels of wheat in one week, or eighteen bushels per day. Last year, in California, human labor, in attendance on a steam thresher and cleaner, could travel from farm to farm and dress and bag wheat at the average rate of 110 bushels per man per day, and in full work could finish 165 bushels per man per day. Such saving of precious time at the critical periods of planting and harvest, and such release of human energy from lower to higher uses, is the result of improvements in the mechanics of the farm.

Chemistry, but a hundred years old, as we might say, has escaped within twenty-five years from the apothecary shop and the dye-house, and gone to work in the fields without disguise. She has always worked there, but anciently did her good deeds for the farmer in a fairy dress, and remained altogether invisible to the common eye.

About the middle of the last century, a lighthouse, known as the Dunston Pillar, was built on the Lincoln Heath, in Lincolnshire, England. It was erected to guide travelers over a trackless, barren waste, a very desert, almost in the heart of England; and long it served its useful purpose. The pillar, no longer a lighthouse, now stands in the midst of a fertile and rich farming region, where all the land is in high cultivation. For twenty-five years no barren heath has been visible, even from its top. Superphosphate of lime, a chemical invention, first applied to land by the British chemist Murray, and brought to the notice of reading farmers by Baron Liebig, has been the chief means through which this great change was effected. Superphosphate over great stretches of English soil makes, or once made, the turnip crop. Turnips there

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support sheep, and with sheep the English farmer knows how to get rich on the poorest light lands.

Liebig, in 1840, called attention to the chemical composition of the guano of Peru. That very year a few casks were imported into England as an experiment. The next year 2,000 tons were brought, and in sixteen years its aggregated sales in Great Britain amounted to $100,000,000. Now Britain, Germany, France, and our seaboard States cannot get enough of it.

Our State of Georgia is officially estimated to expend $10,000,000 annually in the purchase of fertilizers, and single towns in this State lay out thirty to fifty thousand dollars for guano, phosphates, etc., besides using large quantities of home supplies.

Chemistry has taught agriculture how to utilize the refuse of slaughter houses, and fisheries; the bones, the flesh, the blood, which but a few years ago were a waste, a nuisance, and a peril to the public health. It has found vast mines of fossil phosphates in England, Canada, Norway, Spain, France, Germany, South Carolina, Russia, and, but a few weeks ago, in Austria: and has shown how they may be quickly and profitably converted into a precious fertilizer.

Chemistry, by discovering and accurately defining the food-elements of vegetable growth, and by revealing their sources and realizing the means of making them cheaply available to the farmer, has triumphantly overcome one of the previously insuperable obstacles to the development of national wealth.

Agricultural exports impoverish and ultimately exhaust any soil. Only a few favored regions are regularly fertilized by the exceptional arrangements of nature. The Nile valley, in Egypt, is annually top-dressed with the richest and finest *débris* of the tropical jungles and forests of half Eastern Africa, poured over all her acres by a never-failing inundation, and with diligent irrigation is as fertile to-day as it was two thousand years ago.

But Italy, Germany, France, Britain, and the United States, have seen, or are seeing, the productiveness of thousands of their fields decline to a profitless minimum, until lands once beautiful with harvests are desolate and abandoned. But the artificial barrenness of exhaustion, like the natural barrenness of the heath, or the sand-down, yields to the touch of science; and in all the older countries I have named, the work of reclamation is in full progress, and barring some great calamity of politics or nature, we are

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confident that the producing power of their soil will never again be less than now, but will increase many fold in the future, until they become gardens in all their breadth and to the very hill tops.

Many pages might be occupied in recounting the gain which agriculture, like all our industries, has received at the hand of science. It is but a few years since agriculture has been taught in universities and in special agricultural schools, because it is but recently that there has been anything to teach beyond the routine of manual practice that can be learned on any well managed farm. But now the Professor of Agriculture, the Professor of Agricultural Chemistry, the Professor of Vegetable Physiology, of Animal Physiology, find superabundant occupation in acquiring, systematizing, and communicating the facts and truths that constitute agricultural science. If in this country their labors in communicating are not excessive, it is because of special circumstances which will soon be changed.

Much of the advantage which agriculture has derived from science has come to it in the same way that President Clap cheapened the seed drill, viz: "out of regard for the Publick." It was thus that Lawyer Tull, travelling for his health among the vineyards of France, and reflecting on the methods and results of vine culture, conceived those ideas of horse-husbandry, which he afterwards became a landholder for the sake of reducing to practice.

It was thus that James Smith of Deanston, Scotland, a manufacturer intent on bettering the life of his workmen, and substituting wholesome gardening and cow-keeping for the guzzling of beer and other village immoralities, learned those lessons in the thorough drainage and subsoil-plowing of clay lands that have added millions to the wealth and resources of British farms.

It was thus that Theodore de Saussure, of Geneva, Humphrey Davy, of London, and Justus Liebig, of Giessen, initiated those studies in Agricultural Chemistry and Physiology, which have added, and are to add, other millions to the wealth and resources of Europe and this country.

The mowing machine was invented and brought almost to perfection on the glebe of an English parsonage, by an English clergyman, Rev. Patrick Bell. The cotton gin, which raised a barely useful plant to a sudden commercial and manufacturing preëminence, was the unrewarded gift of a New Haven school-master, Eli Whitney, to the country and the world.

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Within a few years farmers, seeing the advantages to be derived from uniting the resources of science with those of practice, in a systematic attempt to improve the methods, operations, and results of agriculture, have begun the establishment of the so-called Agricultural Experiment Stations.

The object of these stations is to make a regular business of discovery for the use of farming. To this end, farmers have formed associations, contributed land, buildings, cattle, labor, money and whatever seemed needful or desirable to prosecute this business. They have undertaken it as a means of making money, a means of saving money. They have wanted to know how to save and use manure, in order to make good crops cheaply; how to save and use cattle food in order to get good beef, wool, and milk cheaply. Aware that accurate and full knowledge of these matters could only be obtained by accurate and numerous experiments, they determined to have the experiments. Feeling that on their own farms the work of experimenting was costly, interfered with the regular business of the place, could not be properly carried on for want of skilled hands, and could not be suitably laid out for want of skilled heads, they united together to bring all these requisites into one focus, so that instead of having to be content with the gratuitous and accidental drippings from the science of the universities and schools, they might have their own well-spring of information, under their own control, and for their own purposes, purely.

They recognized the fact that science had developed the use of many valuable instruments of discovery—the thermometer, the microscope, the balance—that chemical analysis and the art of chemical investigation, which had given to the world phosphorus, superphosphate, chloroform, petroleum, photography, electroplating, and were to give chloral, the superb dyes of coal tar, and an endless list of benefactions, were veritable engines of progress—and they determined to make full avail of them. They saw, too, that the farm was the place where these might most effectually be put to doing farm work, and therefore, in the year 1852, a company of Saxon farmers, constituting the Leipzig Agricultural Society, opened the first *Farmers' Station for Agricultural Experiment*, at the little village of Mœckern, near the city of Leipzig. The society already owned there a small farm, with farm house, barns, and some improved stock and implements. They engaged Dr. Emil Wolff, a young scientist of promise, to take charge, and Mr. Baehr, the manager of the farm, was instructed to superintend

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all the practical detail of experiments. Two or three rooms were fitted up as a chemical laboratory, a small glass house was built for vegetation experiments, an assistant chemist was secured, and the Experiment Station was an accomplished fact.

This was not, indeed, the first association of farmers for scientific investigations in behalf of agriculture, nor was it the first instance of science taking up her abode on the farm. Scotland had her "Agricultural Chemistry Association," that, established for a period of five years, began its operations in 1843, and in 1848 was practically merged in the "Highland and Agricultural Society."

France had, so far back as 1835, in the neighborhood of Strasburg, an experiment station on the farm of Boussingault, who was Professor of Rural Economy in the Conservatory of Arts, in Paris. Both in the laboratory at Paris, and on his estate of Bechelbronn, Boussingault has for forty years carried on a series of most valuable researches, whether considered from the point of view of practice or of science.

When, in answer to the menace of Napoleon, the battalions of Germany swarmed over the fields of Alsace, it was well understood by Bismarck and Moltke that Jean Baptiste Boussingault was not merely a Frenchman, but was also a citizen of the world, a benefactor of every Prussian, Saxon and Bavarian landlord and peasant, and one who held highest rank and had done longest service among the priests and interpreters of nature. Bechelbronn was to them as holy ground, and was sacredly guarded from all molestation.

But Mœckern was the first station where farmers themselves brought science to their own farm to aid them in their own farming. The example there given was so brilliant and solid that within two years another Saxon society, in the town of Chemnitz, set up a second station, and of the twenty-two years that have since elapsed, 1867 is the only one which has failed to witness the founding of one or more similar institutions in Germany or the neighboring countries. The experiment station shortly came to be regarded not as a costly embellishment, or an agricultural luxury, in which universities or wealthy gentlemen might harmlessly indulge, but as a most remunerative and most necessary agency for the use as well as for the education of farmers.

The rate at which the idea of the agricultural experiment station fructified in continental Europe may be gathered from the following statement of the number of stations in existence there at the expiration of each period of five years that has passed since

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the establishment of the station at Mœckern: In 1852, one; in 1857, eleven; in 1862, nineteen; in 1867, thirty; in 1872, sixty-two; in 1875, seventy. There are thus seventy of these experiment stations in Europe, each employing from one to five investigators, trained in the great modern schools of chemistry and physiology.

Some thirteen of these stations are chiefly devoted to the study of cattle feeding, as at Weende, Proskau, and Milan; some twenty-five to experiments on the conditions of vegetable growth, and the action of manures, as at Dahme, and Ida-Marienhütte; some to tobacco and grape culture, as at Carlsruhe; some to grape culture and wine making, as at Wiesbaden and Padua. The station at Udine is devoted to studies in silk production; those at Stockholm and Lodi to milk industry. Thirty stations are largely occupied with analyses of commercial manures. Eighteen stations test the purity and vitality of seeds. Most of the stations, however, combine several of these objects in their operations.

During the years 1852 to 1857 the Mœckern station published five reports of the experiments and researches there conducted, making together a most valuable volume of 574 octavo pages. Many others of the German, Austrian and Italian stations have issued similar reports in pamphlet or book form.

In 1859 began the publication, in Germany, of a special organ of the workers in what had thus grown to be a national enterprise. This journal, entitled *Versuchs-Stationen*, issued in bi-monthly parts, continues to this day. For the first years of its existence it formed a closely printed annual volume of 240 to 360 pages. In 1864 it thickened to nearly 500 pages, and still maintains that dimensions.

In 1863 the number of chemists and investigators connected with the experiment stations and agricultural schools had become sufficient to warrant an annual convention for discussion and exchange of views, and for ten years this general conference of the agricultural explorers of Germany has been only once interrupted, and that by nothing less than the great war of 1866.

Previous to 1870 Italy had no institutions of this kind. In that year a commissioner was sent by the government to inquire into the workings of the German experiment stations. His favorable report led to their immediate establishment, and four were at once organized; nine were in operation in 1873, and now thirteen are in working order.

In the summer of 1874 an International Agricultural Exhibition was held at the great German port of Bremen. Of this exhibition

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the 10th section was exclusively devoted to the experiment station. Thirteen experiment stations and Agricultural Colleges were represented, and a very fair display was made of the various instruments, apparatus and arrangements employed in the stations for the scientific study of agriculture, as well as printed reports and tables, drawings, and diagrams illustrative of the methods and results of investigation. The experiment stations having unitedly declined to receive a money premium, had conferred on them the grand prize of honor of the Senate of the city of Bremen.

But what have the experiment stations accomplished? The farmer's work consists first in converting soil and manures into crops, second in converting crops into beef, mutton, pork, milk, wool, labor and manure. In Europe the farmer often manufactures some of his crops into starch, sugar, wine, alcohol, &c.

The very earliest investigations in the Mœckern station were upon "The feeding of sheep to ascertain the best 'sustaining rations,'" i. e., the best combination of food for simply maintaining the weight and condition of a mature sheep, and upon "The dependency of plants on the atmosphere, and on mineral salts and salts of ammonia." These fundamental questions of agricultural science had been much discussed in the universities and much was known about them, but they were far from a satisfactory solution. On the farms too there prevailed the greatest diversity of opinion as to what constituted a sustaining ration for any given animal, and also as to the extent to which crops depend upon the atmosphere.

Without stopping now to review the state of agricultural doctrine and practice, as it was twenty-five years ago in Germany, or to trace in detail the steps of progress since traversed, I will state briefly some of the substantial advantages that have been gained as the immediate outcome of the efforts of the experiment stations.

1*st*. In respect to the food of plants, it has been settled that potash, lime, magnesia, iron, phosphoric acid, and sulphuric acid must be furnished to all agricultural plants through their roots and by the soil, in order to their growth. It has also been shown that soda, silica, and chlorine are not needful for the early growth of grain crops, but that chlorine is essential for the perfection of the seed, and that silica is probably necessary to uniform blossoming and ripening. It is further proved that water must enter crops through their roots; that carbon, which constitutes more than half their weight, is superabundantly furnished by the air; that air and

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water together yield the materials out of which fully ninety to ninety-eight per cent. of crops is built up ; and that the soil has to give for their nourishment but the two to eight per cent. of mineral matters which remain as ashes when they are burned, and the one-half to two per cent. of nitrogen which they also contain. It is likewise definitely settled that nitrates in the soil are the chief natural source of nitrogen, while the ammonia of manures, as well as a variety of substances containing nitrogen, and found in urine or formed in the decay of dead animals, likewise supply vegetation with nitrogen.

The experiment stations have further ascertained, by a multitude of trials, what quantities and proportions of all these elements are needful to produce any given crop, and to what extent they are removed from the soil. On the other hand, it has been determined what kinds of plant food, and what quantities, are contained in the long list of manures and fertilizers, in all kinds of dung, urine, ashes, salts, guanos, phosphates, manufacturing refuse, etc., etc. The remarkable quality of the soil to sift, as it were, some of the most valuable because most costly fertilizing elements out of manures, retaining them in a form not easily or not largely removed by rain, and yet accessible to the roots of plants—the so-called absorbent or fixing power of soils—has also been elaborately studied. We have thus a pretty complete knowledge of what a crop requires for its growth, what it carries off from the land, what is returned in straw or tops, and where we may look for the most effectual and cheapest restoration of the materials thus removed. The well-instructed farmer is thereby put in possession of the data for keeping accounts between his soil and his crops, so that he can estimate with accuracy what the soil itself can be relied upon to contribute yearly towards their production, and what must be supplied yearly or during each rotation, by means of manures, in order to maintain, to develop, or to increase the fertility of the land.

Dr. Wolff, who conducted the scientific work in the Mœckern station at its beginning, is the author of a valuable series of tables, which are published in a Farmers' Almanac, in Germany, and are largely employed in this kind of reckoning. One of these tables gives the quantities of water, nitrogen, potash, lime, phosphoric acid, etc., in 1,000 parts of all the plants and parts of plants which are encountered in German agriculture, including fifteen kinds of hay, twenty of green forage, nine of roots, eleven of leaves and tops of root crops, twenty-nine of meal, bran, oil cake and other

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manufactured products and by-products, sixteen sorts of straw, eleven varieties of chaff, twelve kinds of commercial plants, such as flax, hops, grapes, etc., fourteen of litter, like forest leaves, ferns, flags, sedge, etc., thirty-four varieties of grains and seeds, and seventeen kinds of animal matters, milk, cheese, blood, meat, wool, etc., making a total of 188 farm products.

Another table gives the composition, in 1,000 parts, of twenty-four varieties of stable and domestic manures, forty-seven kinds of guanos and mineral fertilizers, ten sorts of superphosphates, designated by the material from which they are made, and twelve grades of potash salts.

A third table informs us what 1,000 pounds of barley and fifteen pounds of hops are separated into in the beer manufacture, how many pounds of spirits, grains, spent hops, etc., result, and how many pounds of water, nitrogen, potash, lime, phosphoric acid, etc., exist in each and all of these materials. This table also gives the corresponding products and their composition in case of the manufactures of yeast, of wheat flour, of cheese, of beet sugar, and of flax.

The experiment stations have, by their numerous exact trials, furnished us with rules for calculating from the rations of the animals the composition as well as the quantity of stable manure which is furnished by the different classes of live stock.

By aid of the facts thus made accessible to him, the German farmer can and does economize the resources of his soil, of his manure yard, and of the fertilizer market to a degree that was simply impossible twenty years ago. He can acquire as clear an idea of the state of his soil as to crop-producing capacity, as to what it needs and what it is already possessed of, as he has of his bank account. He can learn whether any course of cropping actually carried out in the past or proposed for the future has removed, or will remove, more or less potash, phosphoric acid, sulphuric acid, etc., from the field than the field has received in manures, or will be likely to yield without disturbing the equilibrium of its stores of plant food.

This cannot be done from these tables alone by any one who is merely able to read them or to reckon by rule of three, any more than the nautical almanac will enable the ship's cook to find latitude and longitude; but the tables give to the farmer who is moderately instructed in the now received doctrines of agriculture, in the matter of crop-production, the data for finding where he stands in relation to his soil and his crop, just as the tables for

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latitude and longitude serve the master of a vessel, who can identify a star and use a sextant to find his position at sea.

We labor here not only under the disadvantage which the educated German farmer has in a good degree overcome, by the use of the permanently valuable facts laid down in these tables, but we likewise suffer from the circumstance, that when we would try to sail by "dead reckoning," there is so much ignorant misrepresentation, or willful fraud practised upon us in throwing the log or by hanging out false lights, that we are in continual uncertainty as to our course.

If we gather from the best consideration of the evidence at our hands that a field needs potash or nitrogen, or phosphoric acid, we find plenty of parties willing to sell us these things, but we also find that we cannot depend upon getting the worth of our money. Our markets are full of "superphosphates," "poudrettes," "tobacco-growers," "bone dust," "bone flour," "ground bone," of "bone meal," "pure," "best," "finest," "celebrated," "rotted," and "dissolved," of "meat scraps," "blood and bone fertilizers," "animal dust," &c., &c., some good, some bad, and in many cases the good appearing to be on the way to the bad. Many of our farmers have laid out their money for some of these things and know that they were cheated, by not getting what was promised and what they supposed they were securing. Some have been bitten so badly that they purchase nothing, unless it is ashes, plaster, bone, fish scrap or something which they can judge of by its looks. Some again have purchased these very fertilizers whose value they believed they could estimate by inspection, only to learn when too late that they had been ingeniously deceived, and that the supposed "bone" contained twenty to fifty per cent. of water, oyster shells, plaster or niter cake, which had no value for their farming.

The German farmers have had the same experience. It is just about twenty five years since in Germany, as here, the trade in superphosphates, guano and similar commercial fertilizers began. The same stupendous frauds by adulteration and dilution of good things were practiced there as they have been and, we have great reason to fear, still are carried on here. But the experiment station has perfectly cured and rooted out these evils in all the districts where it has been established and appreciated. The experiment station there is prepared to furnish the farmers at small cost with an analysis of any fertilizer he proposes to buy. The farmers avail themselves of this aid. They will buy no fertilizer without

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an exact statement of its composition, and they buy with the understanding that any deficiencies in the stipulated amount of fertilizing matters shall be made good or deducted from the payment. Under such circumstances manufacturers can sell nothing that is not substantially what it claims to be. A further result of this system is that low-grade fertilizers are little sought, and those makers who can supply the best article, of uniform quality and at the lowest rates, have the business. With large sales the dealers prosper, while the consumers are satisfied with their purchases, and instead of trying to see how they can get along with small use of purchased fertilizers, they are studying how to use the greatest quantities to advantage. The fertilizer market in Saxony and Prussia, where the experiment station has the universal sanction and confidence of the farmers, is just as settled and satisfactory as any branch of trade, and the farmers there buy superphosphate, guano, potash salts, etc., with as much security of fair dealing as we can feel in the purchase of sugar or nails.

In the second place, the vast interests represented in the feeding of cattle and other live stock have received an equal share of attention, and although the questions involved are in the highest degree complicated and abstruse, an encouraging measure of success in approaching their solution has been attained.

In our agricultural meetings and publications we are discussing the same old questions as to the value and economy of the various kinds of cattle food, and the methods of raising them, that have been discussed ever since there have been two ways open to the farmer for keeping his animals.

So long as we do not understand what hay, corn-fodder, corn-meal, oil-cake, bran, shorts, brewers' grains, etc., are in their distinct parts, and how their separate ingredients individually stand related to the wants of the living, growing, laboring, milk-giving, or fattening animal, so long we shall remain in a fog of discussion, so long we shall oppose each other in argument, in belief and in practice; so long, like men bewildered in the forest, we shall travel in a circle, and tire ourselves out without making progress forward.

In the tables which I have alluded to, in which a vast amount of the work of the Experiment Stations has been condensed to its results, in compact numerical statement, we find given the average quantities of water, albuminoids, carbohydrates, fat and cellulose, that are contained in 1,000 parts of each of some 200 kinds of forage and feeding stuff. Chemical analysis encounters

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extraordinary difficulties in its attempt to set forth the separate elements of food. Many of these difficulties are as yet but partially overcome, and many of our results are in some measure merely tentative and provisional; but a vast advance has been surely accomplished.

We can compare together hay and cornstalks, oats and cornmeal, peas and oil-cake, potatoes and turnips, by a comparison of their water, their albuminoids, their carbohydrates, their fat, and their fiber. We can also connect the preponderance of one or other class of ingredients with their observed use in cattle feeding.

The Experiment Stations have carried out a large number of feeding trials on oxen, cows, calves, horses, sheep, swine, and goats, taking account of the accurately weighed and analyzed food, not merely as so much hay, beets, etc., but also as so much water, fat, starch, gluten, etc.; and have thus given a new, more definite and more general expression to the results which practice had obtained.

As in the construction of a house, the builder must know not only the materials to be provided, but also the due proportions of them to be employed, so in the raising of a calf, in the fattening of an ox, in the support of a draught horse or of a milch cow, the farmer should know, not merely that water, oil, albuminoids, etc., are absolutely required, but also that they are demanded in such and such proportions. The nails and pins that are put into a house, beyond what are needed for binding the structure, are not only a waste of material in themselves, but may become a detriment to the building. So the want of due proportion among the elements of cattle food may be, and unquestionably is, in fact, an immense waste and damage to our agriculture.

In the Experiment Stations great numbers of practical trials have been carried out for the purpose of ascertaining the best quantities and proportions of the food-elements to use for the various purposes of the stock keeper, and the results that are now accepted as the best approximation to truth, are given in tables of so-called "Normal Rations."

These "Normal Rations" are confessedly approximate and imperfect; but they are based upon experiment, and they have an undeniable value. By their help the farmer can calculate the probably best combination of any sorts of cattle food that are at any time accessible to him. He can determine what to buy and what to sell to the best advantage of his cattle, his manure heap, and his cash on hand. And although the experimental foundation

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of these tables is not yet broad enough to support all the deductions that may be made from them, they have been useful in practice, and are invaluable as a safe basis for further inquiries.

The builder, in making his estimates of the materials needful to construct a house, allows, in case of lumber, a large percentage for loss by defects and unavoidable waste in cutting. He also provides for a small waste of nails, while most of the other hardware required is expected to "hold out." The waste portions of cattle food must in like manner enter into the farmer's estimates. He must know to what degree the animal can build into its structure or otherwise make profitable use of the elements of all varieties of feeding stuff.

From this point of view, another class of investigations has been actively prosecuted for some ten years as to the digestibility of different foods; not with reference simply to what proportion of hay or potatoes or cotton-seed meal is dissolved and consumed in gross, but what proportions of the fat, of the starch, of the albuminoids, of the fiber, of the phosphates, etc., are utilized as nutriment. These investigations are made by feeding known quantities of analyzed food, keeping account of gain or loss of live weight, and also collecting, weighing and analyzing the urine and dung. What enters the animal as food, that cannot be found again unaltered in the excrement, has been digested.

The digestibility of a given cattle-food is not invariable, but changes according to the kind of animal, and the articles that accompany it in the ration; but by numerous experiments it is expected that a series of average figures will be obtained which will serve usefully as a basis for estimating the relative values of different feeding stuffs.

One of the interesting results of these researches is that the fiber or cellulose—the very wood—of plants is to a considerable degree digestible. It has "always" been known that the beaver subsists on wood and bark during winter, that cattle derive great satisfaction from browse, and that goats will eat newspapers and cotton cloth. Exact trials have shown that sheep are able to digest a large proportion of sawdust and of pure paper pulp, and that all farm animals readily convert into food from 40 to 70 per cent. of the fiber or woody matter of hay, straw and chaff. In fact, these materials have been proved to be not simply digestible "on a pinch," but really serviceable to a corresponding degree with starch, sugar, oil, etc. Accordingly, in most of the well com-

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pounded cattle rations, the second rank in respect to quantity is occupied by cellulose or "crude fiber."

It is remarkable how differently the same elements of various kinds of forage submit to digestive action, as exhibited in the following results of this class of experiments.

Percentage of organic matter digested.

	No. of Experiments.	Total Organic Substance.	Albuminoids.	Fat.	Fiber.
Meadow hay,	45	64	59	50	62
Clover hay,	18	60	59	59	47
Clover, just before flower,	4	71	85	66	56
" in full flower,	2	64	69	61	50
" past flower,	2	58	59	44	39
Potatoes,	13	90	66	53	27
Linseed cake,	8	81	86	90	69
Cotton-seed cake (with hulls),	4	50	74	91	23
Oats,	9	69	75	78	20
Rye straw,	5	51	24	32	62

The above figures are simply averages of the results of trials made in most cases by different experimenters on different animals. In case of meadow and clover hay they are perhaps so numerous as to fairly establish the superiority of the former, by showing that although clover hay contains some four per cent. more albuminoids than grass hay, it gives no more of them to the support of animals, while its fiber is far less digestible. The influence of age on the digestibility of forage is strikingly seen in case of clover, the percentage value of which decreases rapidly during flowering and ripening. Potatoes and linseed cake are among the most concentrated and digestible of foods; and cottonseed cake, when free from hulls, ranks but little inferior to linseed cake. It is observed that rye straw is food to the extent of one-half its weight; while of the grain of oats 30 per cent. is undigested. But the albuminoids of oats are thrice more nutritious than those of rye straw; and the cellulose of the straw is thrice as nutritious as that of oats. The belief so prevalent in this country, that Indian corn is unsurpassed among the grains as a food, finds confirmation in these researches, its relative digestibility being higher than that of barley, as well as that of peas and beans. It is evident that experiments which promise to give us the data for comparing the digestibility of different foods, are of the utmost importance. By their aid the compounding of really normal rations will become a matter of satisfactory certainty, and the economy of cattle food will be pushed to near its limits.

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A third direction in which the Experiment Station is proving of direct service to the farmer is in the examination of seeds as regards their genuineness, purity, and germinative quality. It is but a very few years since attention was directed in Great Britain to the wholesale distribution of purposely adulterated seeds throughout that country, and stringent laws and severe penalties were there enacted to protect the farmer.

There lately flourished in London, establishments where the business of "doctoring" turnip-seed was prosecuted on an extensive scale. Old and worthless seeds, or the seeds of inferior kinds of turnips, were killed and colored, and used to the estimated amount of 20,000 bushels annually for adulterating the seed of those varieties most sought for by farmers.

In London and on the continent hundreds of tons of the cheap yellow clover seed (*Medicago lupulina*) were and still are mixed in larger or smaller proportions with the red clover seed, and sold at the high price of the latter.

In 1868, three tons of so-called red clover seed were sold to farmers in the Saxon city of Chemnitz alone, of which two-thirds was yellow clover.

In Saxony light and inferior kinds of oats are extensively bought by seedsmen to adulterate the heavy and prized sorts.

The celebrated "Probstei rye" is annually produced to the extent of 2,800 to 3,400 bushels; but the amount ostensibly disposed of in the seed trade is hundreds of thousands of bushels.

Dr. Nobbe, Director of the Tharand Experiment Station, reports finding in a sample of tall meadow fescue grass (*Festuca elatior*) 70 per cent. of adulteration; and two samples of so-called "grass seed," having all the external appearance of a good article, were found to consist of grass flowers only, without a ripe seed of any sort.

The climax of this kind of ingenious villainy appears to have been reached in Hamburg, where there recently existed a manufactory of counterfeit clover seed, which was made from quartz sand, and with such skill as to deceive experienced judges, who have pronounced samples containing 25 per cent. of these quartz grains to be pure red clover seed.

In a sample of Timothy seed which had the appearance of being very pure, Dr. Nobbe found about 7 per cent. of foreign seeds, in which he identified 31 different kinds, mostly weeds and inferior grasses; and he calculated that upon a Saxon acre (= 1.37 Eng. acres) no less than 1,700,000 of these foreign seeds would be sown,

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or 24 upon every square foot, by using the customary quantity of this pure Timothy seed.

Dr. Nobbe examined, during the first four years since the Tharand Experiment Station has given this matter attention, some 1,700 samples of seed. He determines not only the extent of adulteration with foreign seeds and mixtures, but he also ascertains, by careful sprouting trials, what percentage of the genuine seed is alive and capable of producing vigorous plants.

Dr. Nobbe has, by very numerous and laborious experiments upon seeds procured from various localities and climates, determined what must be regarded as the average per cent. of good seed that will sprout and grow, in a number of various kinds, when genuine. His experience shows that unadulterated white clover seed of which 66 per cent. will germinate is of average quality; flaxseed of which but one-half will sprout is poor; while dill seed of which 10 per cent. comes up is excellent.

Dr. Nobbe's experiments show further that very many genuine commercial seeds are of inferior quality, yielding much less than the proper average of plants, probably from admixture with the fresh stock, of old seed whose vitality is impaired or destroyed.

The many complaints that are made of the poor quality of the seeds sent out by the Agricultural Department at Washington are in large degree explained by these revelations of the state of the trade in Europe.

It is but six or seven years since Dr. Nobbe first called public attention to this subject. He has begun the publication of a book containing full descriptions and figures of all the useful and hurtful seeds that occur in commerce; and already at some twenty Experiment Stations farmers are able to get trustworthy examinations of seeds as to purity and vitality, and at a trifling cost.

To say that the farmers of Connecticut and of our entire country urgently need the aid and stimulus of the Experiment Stations, is to make a most evident assertion. Our Agricultural Colleges have but few agricultural students. The Agricultural Course of Instruction in this School is a supply that meets little demand. The reason lies mainly in the fact that our intellectual activity has the habit of running in other than agricultural channels. To bring our farmers in direct and profitable contact with the results of science, to bring science into active and visible coöperation with the toils and plans of the farm, would redound to the eminent advantage of both. The Experiment Station, I cannot doubt, is to be this point of contact, the focus of this coöperation.

SAMUEL W. JOHNSON.

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Instruction in the Use of the Plane Table.

A class was again formed, during the summer of 1874, from the students of the School, to receive instruction in the use of the plane table and in field work under the operation of the United States Coast Survey; permission to that effect having been granted by Captain C. P. Patterson, Superintendent of the Coast Survey, to Mr. Richard Meade Bache, Assistant in charge of the region about New Haven. It was the original intention of Mr. Bache to place two parties from the School in the field, but the lateness of the passage of the Coast Survey appropriations by Congress prevented this, as before authority to act could be received most of the students had dispersed. The members of the school who volunteered were Messrs. E. C. Savage, George R. Cooley, A. A. Browning, and Henry A. Hazen, and the first of these was put in immediate charge of the party, and was rated and paid as an Aid *pro tem.* upon the Coast Survey. Mr. Bache has courteously furnished the Governing Board with a report of the operations of the party, in which he gives the statistics of the work, as follows:

Area,	1.8 sq. miles.
Length of streets and roads,	20.7 miles.
" " horse railroad,	1.9 "
" " steam railroad,	1.5 "

The map was inked at the end of the field season by Mr. E. C Savage.

Contributions to the Study of the New Haven Regio

"I herewith enclose," Mr. Bache adds in his communication t the Board, "from last season's work, a list of such, and only suc statistics of my regular parties' operations as have heretofor been published in the Annual Report of the School. The operators in these parties were Messrs. Horace Andrews and Neville B. Craig, of whom Mr. Andrews executed the triangulation under my direction, and Mr. Craig the levelling, from which, among many other heights, the additional ones given are selected."

Permanent Bench Marks established between Tomlinson's Bridge and New Haven Light House.

Referred to the datum plane used by the City Surveyor's office, which is the mean high water at Chapel st. bridge, as determined by the Coast Survey tidal observations of 1870.

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Quartz pebble in north wall of dike at the east end of Tomlinson's bridge—east end of wall—second stone from end, on top of wall and near the north-east corner of stone. 6.871 ft.

East corner of granite post, at the north-east corner of Ft. Hale property, and situated on the north side of north road leading to Ft. Hale. 2.862 ft.

Copper bolt in wall on the north side of the sluiceway at Ft. Hale. 5.385 ft.

South corner of granite post, at the south-east corner of the Ft. Hale property, and near the south-west corner of the west saltpetre works. 4.015 ft.

North-west corner of granite post, situated about 109.5 feet from the last bench, and on the opposite side of road. 2.757 ft.

On top of stone post on west side of east entrance to yard of first house west of George Nettleton's hotel at Morris Cove. 16.556 ft.

Copper bolt placed in solid rock a few feet west of New Haven light-house. and marked 11.187 ft.

*Geographical Positions in the Vicinity of New Haven, Conn.**

Name of Station.	Latitude.			Longitude.		
	°	′	″	°	′	″
Ives's Cupola,	41	18	29.288	72	52	31.704
Sandy Point (signal on beach),	41	16	01.741	72	55	14.830
Wire Works' Chimney,	41	17	53.682	72	53	23.355
Townsend's Cupola,	41	16	31.786	72	53	24.976
Peak on House (east shore),	41	16	33.499	72	53	53.809
White House Cupola (east shore),	41	17	22.055	72	53	49.793
Mitchell's Cupola (S. W. corner)	41	16	23.856	72	53	26.925
Chemical Works (wooden ventilator),	41	16	05.478	72	53	47.054
Rod (supporting telegraph wire),	41	18	54.423	72	52	54.424
Slaughter House (east cupola),	41	19	14.876	72	53	12.980
School House Cupola (adjusted),	41	18	32.793	72	53	06.043
Baldwin's Cupola (adjusted),	41	17	40.244	72	53	21.781
2d Cong. Church (Fair Haven, east side),	41	18	25.498	72	52	48.509
North (signal pole),	41	17	33.479	72	53	55.567
Crane's Bar (signal pole),	41	17	03.730	72	53	53.663
East (signal pole),	41	16	56.350	72	53	38.218
Red and White (signal pole),	41	17	04.637	72	53	28.775
Fort Hale (signal pole),	41	16	12.372	72	53	58.301
North Watch House (signal pole),	41	16	41.993	72	54	49.210
Grove (signal pole),	41	19	00.580	72	52	36.932
Pine Street (signal pole),	41	18	45.386	72	52	56.263
Shell Heap (signal pole),	41	18	41.189	72	52	38.638
Peck Street (signal pole),	41	19	00.047	72	52	58.715
North Quinnipiac (signal pole),	41	19	26.326	72	53	00.479
South West Ledge Light House,	41	14	01.724	72	54	24.800

Distances between Triangulation Points within the New Haven Region.

	Feet.
Ives's Cupola to West Rock,	23,731.45
" " Tall Spire,	3,535.58
" " South Church,	14,336.70
" " Baldwin's Cupola,	6,264.14
" " 2d Cong. Church, Fair Haven,	1,338.55
" " School House Cupola,	2,644.07
" " Grove Signal,	3,191.53
" " Peck Street Signal,	3,733.08
" " Pine Street Signal,	2,482.90

* To reduce these positions, as well as those previously published, to the most recent astronomical data of the Coast Survey, add 0.″30 to the latitude and 20.″43 to the longitude. It is not done here, to avoid want of uniformity with previous publication in the Report, and was not done there, because the Coast Survey had not then made the general change.

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South Church	to Baldwin's Cupola,	10,045.18
"	" Sandy Point Signal,	11,147.89
"	" Mitchell's Cupola,	13,036.95
"	" Townsend's Cupola,	12,621.90
"	" Chemical Works' Ventilator,	13,384.22
"	" Fort Hale,	12,313.04
"	" Crane's Bar,	8,944.34
"	" Peak on House,	10,886.64
"	" White House Cupola,	8,379.26
"	" Wire Works' Chimney,	9,868.17
"	" North Watch House.	7,736.74
"	" North Signal,	7,617.83
"	" East Signal,	10,340.01
Sandy Point Signal	to Townsend's Cupola,	8,921.29
"	to Mitchell's Cupola,	8,537.10
"	" North Watch House,	4,518.67
"	" Chemical Works,	6,712.67
"	" White House Cupola,	10,402.02
"	" Fort Hale Signal,	5,941.31
"	" Crane's Bar Signal,	8,817.59
"	" Peak on House,	6,970.89
"	" Forbes' Signal,	12,411.34
"	" North Signal,	11,081.53
"	" East Signal,	9,216.42
Townsend's Cupola	to Mitchell's Cupola,	816.17
"	to Fort Hale Signal,	3,214.63
"	" Crane's Bar Signal,	3,904.45
"	" Peak on House,	2,208.01
Chemical Works' Ventilator	to Peak on House,	2,882.16
Baldwin's Cupola	to Tall Spire,	5,285.26
"	to East Rock,	12,585.26
Crane's Bar Signal	to Peak on House,	3,059.33
"	to White House Cupola,	1,877.89
"	" North Signal,	3,014.10
"	" East Signal,	1,395.67
"	" Red and White Signal,	1,902.02
Fort Hale Signal	to Crane's Bar Signal,	5,209.36
"	to Peak on House,	2,165.34
"	" North Watch House Signal,	4,908.31
Wire Works' Chimney	to East Rock,	11,245.83
North Watch House Signal	to Forbes's Signal,	7,945.40
Slaughter House Cupola	to North Quinnipiac Signal,	1,500.71
East Signal	to Red and White Signal,	1,105.92
"	to Peak on House,	2,600.75
"	" North Signal,	3,984.02
Grove Signal	to Tall Spire,	4,229.69
"	" Slaughter House Cupola,	3,107.54
"	" Telegraph Rod,	1,472.84
"	" Pine Street Signal,	2,130.58
"	" Shell Heap Signal,	1,966.69
"	" Peck Street Signal,	1,662.81
"	" North Quinnipiac Signal,	3,164.77
Peck Street Signal	to Fair Haven 2d Cong. Church,	3,582.03
"	to Slaughter House Cupola.	1,853.76
"	" Telegraph Rod,	656.64
"	" Shell Heap Signal,	2,447.23
"	" North Quinnipiac Signal,	2,662.80
Shell Heap Signal	to Fair Haven 2d Cong. Church,	1,757.41
"	to School House Cupola,	2,257.08
"	" Telegraph Rod,	1,801.23
"	" Pine Street Signal,	1,410.26
S. W. Ledge Light House	to West Rock,	38,125.95
"	" " South Milford,	30,074.85

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Additions to the Zoological Collections.

A. E. Verrill, Curator; S. F. Clark, Assistant.

The most numerous additions to the Zoological department are the extensive collections of marine invertebrates made in connection with the explorations under Prof. S. F. Baird, U. S. Commissioner of Fish and Fisheries. During the past summer the headquarters of the Commission were established at Noank, Conn., and the investigation of the marine invertebrate fauna was put under the general charge of the curator, but a large number of other naturalists aided, more or less, in this work; among them Mr. S. I. Smith, Mr. Oscar Harger, and Mr. S. F. Clark, of this School; Prof. A. Hyatt and Mr. Robert Rathburn, of Boston; Dr. Joseph Leidy, of Philadelphia; Dr. E. Bessels, of Washington. Mr. R. Y. Brown, of the University of Wisconsin; Mr. G. R. Kleeberger, Mr. J. C. Olmstead, and Mr. F. M. Turnbull, students in this School, also took part in the work, and availed themselves of the facilities offered for the study of marine zoology and botany. Extensive dredgings were made by means of the U. S. Steamer "Bluelight," Commander L. C. Beardslee, in the waters of Long Island Sound; Fisher's Island Sound; Gardiner's Bay; Peconic Bays; Block Island Sound; and the deeper waters off Block Island and the eastern end of Long Island. This collection of invertebrata has been deposited in the North Sheffield Hall, to be examined and reported upon by the curator and Mr. S. I. Smith, when a complete series of the specimens will be given to the college museum. Much work has been done during the past year upon this and the previous collections of the same kind, made during 1872 and 1873. Mr. Smith, Mr. Clark, and Mr. Harger have aided the curator in this work.

In September, the Superintendent of the U. S. Coast Survey offered to Prof. Baird the use of the Coast Survey steamer Bache, Capt. Platt, for the purpose of continuing the dredgings in deep water off the coasts of Maine and New Hampshire. Dr. A. S. Packard, of Salem, Mass., was put in charge of this expedition, and he was assisted by Mr. C. Cooke, of Salem, and Mr. Robert Rathburn, of Boston. They obtained a valuable collection of the deep-water animals of the Gulf of Maine, which has also been sent to this School for examination and description. A preliminary report upon the results of the last named expedition has been published in the American Journal of Science by the curator. We have also received from the U. S. Fish Commission several

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large fishes taken near Noank, the skins of which have been mounted and put on exhibition. Among these are the drum-fish, the tarpum (*Megalops thrissoides*), and bill-fish (*Tetrapturus albidus*). These are rare species on the coast of New England.

A good collection of shells, corals, echinoderms, and crustacea, from Florida and the Bahamas, was purchased of Dr. E. Palmer. A very valuable and useful collection of typical crustacea was obtained by exchange from the University of Christiania, through Dr. G. O. Sars. A small but valuable collection of typical Hydroids and Ophiurans was received from the Museum of Comparative Zoology, in exchange.

Mr. J. F. Whiteaves has sent a collection of invertebrates from the deep waters of the Gulf of St. Lawrence. Mr. J. H. Emerton has labelled most of our spiders, and has sent a considerable number of additional ones.

Professor Marsh has continued to make numerous and valuable additions to the osteological collection, as in previous years.

Professor Dana has given many valuable books to the zoological department of the museum.

Several works relating to the culture and fisheries of oysters were presented by Capt. G. H. Townsend.

Other donations, of less importance, have been received from a number of persons, and will be acknowledged on another occasion.

Additions to the Geological Collections.

O. C. Marsh, Curator; O. Harger, Assistant.

The additions to the Geological department of the Museum have been very large during the past year. In the West, twelve parties of collectors were employed by the curator during the summer and autumn months, and many thousand specimens of Cretaceous and Tertiary vertebrate fossils were thus obtained, among them many new to science. In October last, the curator organized an expedition to the Miocene "Bad Lands" south of the Black Hills, more especially to examine a remarkable fossil locality discovered a few months previously. The explorations were very successful, notwithstanding extremely cold weather (15° to 20° below zero), and the continued hostility of the Sioux Indians. The latter refused to allow the expedition to cross White River, but a reluctant consent was at last obtained. They afterwards stopped the party on the way to the "Bad Lands," attempted a night attack on their camp, and otherwise molested

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them. The fossil deposits explored were mainly of Miocene age, and although quite limited in extent, proved to be rich beyond expectation. Nearly two tons of fossil bones were collected, most of them rare specimens, and many unknown to science. Among the more interesting remains found were several species of gigantic *Brontotheridæ*, nearly as large as Elephants. Successful explorations were made also in the Pliocene of the same region.

Among the important vertebrate fossils secured during the last year, and already described by the curator, are several forms of Quadrumana from the Eocene and Miocene; a number of species of a new order (*Tillodontia*) of Eocene Mammals; a new genus of *Brontotheridæ;* numerous Tertiary Mammals allied to the Horse; and the first horned Rhinoceroses discovered in this country.

One of the most interesting specimens added to the museum is a nearly complete skeleton of *Mastodon Americanus*, found by Mr. Andrew Mitchell, on his farm in Otisville, Orange County, New York. This skeleton belonged to a fully adult animal, and is in better preservation than any yet discovered in this country.

The Osteological collection of this department has been greatly increased during the year. Several hundred skeletons, especially of Mammals and Birds, have been added, representing many rare types. The most important acquisition in Osteology was a large collection of skeletons and skulls, purchased of Dr. H. W. Boyd of Chicago. Among these was a fine series of Quadrumana, including Gorillas, Chimpanzees, and Orangs, and a Whale, over seventy feet in length, from the Pacific Coast.

Mr. G. B. Grinnell (class of 1870), Palæontologist of the Black Hills Expedition under Gen. Custer, and Mr. F. H. Hoadley (class of 1870) of New Haven, have rendered important service to the Geological department of the Museum, during the past year, especially in arranging and classifying the collections.

The new Peabody Museum Building is now in process of construction, and it is expected that during the next year all the collections of this Department will be placed in it, and be accessible.

Donations to the Metallurgical Museum.

The most noteworthy additions to the Metallurgical Museum are a suite of Zinc ores from the Passaic Mine, Stirling Hill, New Jersey, presented by Henry S. Manning, Esq. (S. S. S. 1863), of Manning & Squier, New York City; and specimens of Silver ore from the great Comstock Bonanza, California, Mine, Virginia City, Nevada, the gift of Hon. William Alvord, San Francisco, Cal.

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Public Lectures.

The ninth annual course of lectures to mechanics and others was given during the past year in the lecture room in North Sheffield Hall. The lecturers and their subjects are indicated in the annexed programme.

I.	Mon.,	Feb. 1.	Modern Glaciers (1),	W. H. Brewer.
II.	Thurs.,	" 4.	The Growth of Language (1),	W. D. Whitney.
III.	Mon.,	" 8.	Modern Glaciers, (2),	W. H. Brewer.
IV.	Thurs.,	" 11.	The Growth of Language (2)	W. D. Whitney.
V.	Mon.,	" 15.	Agricultural Experiment Stations,	S. W. Johnson.
VI.	Thurs.,	" 18.	The Growth of Language (3),	W. D. Whitney.
VII.	Mon.,	" 22.	The Gulf Stream,	W. P. Trowbridge.
VIII.	Thurs.,	" 25.	The Growth of Language (4),	W. D. Whitney.
IX.	Mon.,	March 1.	Ancient Glaciers,	A. E. Verrill.
X.	Thurs.,	" 4.	Chemical Analysis,	W. G. Mixter.
XI.	Mon.,	" 8.	On the New Revision of the English Bible,	President Woolsey.
XII.	Thurs.,	" 11.	The National Debt,	F. A. Walker.
XIII.	Mon.,	" 15.	Cotton,	D. C. Eaton.
XIV.	Thurs.,	" 18.	Magnetism,	C. S. Lyman.

Gifts to the Institution.

A powerful electro-magnet, with auxiliary apparatus, has been very generously presented to the School by its manufacturer, William Wallace, Esq., of Ansonia.

The soft iron cores of the magnet, each two feet long and four inches in diameter, are bolted to a heavy iron block, and are surrounded each by four spools of insulated copper wire No. 8, each spool containing 32 pounds of wire in 11 layers of 33 convolutions to a layer, the total length of wire being nearly a mile. The magnet is very conveniently mounted on trunnions in a heavy mahogany frame, so as to be readily used in any position. To the free ends of the cores are fitted elaborately constructed and massive iron pieces, which carry the polar terminals, and these terminals (of which there are three pairs) are adjustable for distance apart by large hand-screws. There is also a massive armature to connect the two cores for lifting, when the polar pieces just described are removed. Besides the solid cores already mentioned there is an extra pair of hollow ones, each having a central cavity two inches in diameter, and at one side a quarter of an inch slot cut entirely through the tube from end to end. These cores may be jointed to each other endwise by a double connecting screw, so as to form a straight magnet four feet in length.

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The principal auxiliary pieces are for exhibiting the effects of induced currents. They comprise a one and three-sixteenths inch copper cube for rotation; a heavy copper plate 28 inches long, 5 wide, and about two-tenths thick, connected by brass rods with an axis of suspension 5 feet above, so as to vibrate lengthwise, as a pendulum, between the poles; and a copper disk of the same thickness and 18 inches in diameter, which is made to rotate rapidly between the poles by means of a crank and heavy frictional gearing.

The lifting force of the magnet is estimated at eleven tons.

To this munificent gift Mr. Wallace has since added a very valuable piece of apparatus, consisting of a coil 12 inches long and 5½ inches diameter, with a movable iron bar an inch in diameter and 18 inches long, for vibrating vertically in the central cavity; the whole mounted on a mahogany stand.

From the Class of 1872, through its Secretary, Mr. C. L. Johnson, the Governing Board acknowledge the receipt of a gift of $400.

The Library has been also the recipient of gifts from various persons, among which may be mentioned thirteen volumes of fac similes of the medals and other works of art preserved in Rome, presented by Mr. Sheffield; five volumes, with atlas, of Karsten's Metallurgie, presented by Mr. H. Holland of Westfield, Mass.; and the various publications of the Engineer Department of the United States Army.

Necessity for Increased Endowments.

The Governing Board are again under the unpleasant necessity of making reference to the need of additional endowment for the proper maintenance of the School; and they feel it to be due both to themselves and to the friends of the institution that the precise facts should be made known. For the past two years, in spite of the most rigorous economy, the annual expense has exceeded the annual income. True, the deficit has thus far been comparatively small; but the cause which produced it is still in active operation, and is likely to become more powerful with each succeeding year. The additional teaching force required for the steadily increasing number of students cannot be paid for from the income received from tuition alone; and above a certain point every additional student is a drain upon the resources of the institution. It is obviously the wish of all interested in the prosperity of the

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School that the number of thoroughly prepared pupils connected with it should constantly become greater; but it is certainly full as desirable that the efficiency of the instruction given should not be impaired. The only practicable way to economize at present, so as to make the resources of the School meet its current expenses, is either to cut off a portion of the present teaching force, or to employ inferior instructors at smaller salaries; neither of which alternatives the Governing Board are disposed to look upon with the slightest favor. They are necessarily compelled to call upon the friends of scientific education, and to once more ask that additional efforts may be made to secure a still larger endowment to the permanent fund of the School.

Anniversary.

The anniversary exercises were held in North Sheffield Hall on the evening of Tuesday, June 23, 1874. Nine theses were selected for public reading.

The candidates for degrees, with the subjects of their theses, are given in the following schedule. Those marked with an asterisk were read in the evening.

CANDIDATES FOR DEGREES,

WITH THE SUBJECTS OF THEIR GRADUATING THESES.

CIVIL ENGINEERS. (2)

Joseph Jackson Abbott, Ph. B., *New Haven.* Design of an Iron Bridge of Large Span (Murphy-Whipple Truss).

Joseph John Skinner, Ph. B., *New Haven.* Design of an Iron Bridge of Large Span (Post Truss).

BACHELORS OF PHILOSOPHY. (36)

Henry Prentiss Armsby (Chemistry), *Millbury, Mass.* On the Nitrogen of the Soil.

Nathan Edward Beckwith (Civil Engineering), *New Haven.* On Natural Hydraulic Cement.

Charles Cook Brewster (Civil Engineering), *Norwich.* On Foundations under Water.

Edward Brush (Civil Engineering), *Greenwich.* A Review of the Foundation of the Pier of the East River Bridge.

Arthur Bucklin Claflin (Select), *Boston, Mass.* On Cabinet Government.

Franklin Edwards (Civil Engineering), *Northampton, Mass.* On the Water Works of Northampton, Mass.

Charles Howard Fitch (Dynamic Engineering), *New Haven.* On Rotary Steam Engines.

Edwin Horace Forbes (Civil Engineering) *Cromwell.* A Review of the Canal at Windsor Locks.

Le Roy Gale (Medical), *New York City.* On the Reproduction and Metamorphoses of the *Bufo Americanus.*

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JACOB HOUTZ GROVE (Select), *Fredericksburg, Pa.* On the Origin and Growth of the Jury System.

VINCENT GILPIN HAZARD (Dynamic Engineering), *West Chester, Pa.* On Belting.

FRANK LEROY HOLT (Select), *Rockville.* On the Relations of the Physical Geography of the United States to their Settlement.

ALLEN BREWER HOWE (Metallurgy), *Troy, N. Y.* On the Nature and Manufacture of Spiegel-Iron.

*HENRY HUN (Medical), *Albany, N. Y.* On the Luminous and Non-Luminous Flames of the Bunsen Burner.

*LORENZO M. JOHNSON (Civil Engineering), *Rochester, Mass.* On the Hoosac Tunnel.

HENRY JARVIS KELLOGG (Civil Engineering), *Milford.* A Review of the Swing Bridge over the Housatonic River on the N. Y., N. H. & H. R. R.

CHARLES HITTELL KILLINGER (Chemistry), *Lebanon, Pa.* On the Cornwall Iron Ore Bank in Lebanon County, Pa.

BEVERLY LIVINGSTON (Medical), *New York City.* On the Marine Algae of Long Island Sound.

WILLIAM PITT LYNDE (Dynamic Engineering), *Milwaukee, Wisc.* On Governors.

*WILLIAM MCGRATH (Civil Engineering), *Bridgeport.* A Review of a Roof Truss in the Grand Central Depot, New York City.

*CHARLES JAMES MORSE (Civil Engineering), *Poland, O.* A Review of the Iron Blast Furnace at Struthers, Ohio.

GEORGE SMITH NEEDHAM (Civil Engineering), *Louisville, Ky.* On the Ohio Falls Bridge at Louisville, Ky.

*EUGENE ERNEST OSBORN (Civil Engineering), *Norwalk.* On Pavements.

RICHARD DEANE ARDEN PARROTT (Chemistry), *Greenwood Works, N. Y.* On the Working of the Clove Furnace at Greenwood, N. Y.

CLAUDIUS VICTOR PENDLETON (Dynamic Engineering), *Bozrah.* On Compound Engines.

*WALTER BREWSTER PLATT (Medical), *Waterbury.* On the Anatomy of the Quahog-clam (*Venus Mercenaria*).

*GEORGE COFFIN POWER (Civil Engineering), *Hudson, N. Y.* A Review of the Draw of Harlem Bridge.

WILLIAM SPENCER PRATT (Civil Engineering), *New Haven.* On Cement *vs.* Glazed Pipe for Sewage Purposes.

WILLIAM HENRY REYNOLDS (Civil Engineering), *New Haven.* A Review of an Iron Road-Bridge over the Quinnipiack River at Wallingford, Conn.

*WILLIAM ROCKWELL (Dynamic Engineering), *Bridgehampton, N. Y.* On Explosives and their Applications.

WILLIAM ARTHUR ROGERS (Metallurgy), *Covington, Ky.* On the Bessemer Steel Process.

JOHN MUIRHEAD STEWART (Civil Engineering), *Peekskill, N. J.* On the Lyman Viaduct.

FRANCIS HILL STILLMAN (Dynamic Engineering), *Plainfield, N. Y.* On the Teledynamic Transmission of Power.

*WILLIAM RICHARDSON UPHAM (Medical), *Yonkers, N. Y.* On Lygodium Palmatum.

SIMEON HARRISON WAGNER (Civil Engineering), *West Haven.* On Double Reversible Continuous Rail for Railway Tracks.

JOHN CHARLES WEBER (Civil Engineering), *New York City.* A Review of the Stone Bridge over Mill River on the H. & N. H. R. R.

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Prizes.

CLASS OF 1874.

For excellence in German, the prize awarded to HENRY HUN, *Albany, N. Y.*, with honorable mention of EUGENE E. OSBORN, *Norwalk.*

For excellence in French, the prize awarded to HENRY HUN, *Albany, N. Y.*

For excellence in Civil Engineering, the prize awarded to CHARLES J. MORSE. *Poland, O.*

CLASS OF 1875.

For excellence in Mathematics of Junior Year, the prize divided between CHARLES HILDEBRAND, *New Haven*, and WILLIAM F. PRATT, *New Haven.*

For excellence in Chemistry, the prize awarded to FREDERIC N. PEASE, *Ellington.*

For excellence in Mineralogy, the prize awarded to FREDERIC N. PEASE, *Ellington.*

CLASS OF 1876.

For excellence in all the studies of Freshman Year, the prize awarded to HIRAM A. MILLER, *New Haven.*

For excellence in German, the prize awarded to MAX MAILHOUSE, *New Haven*, with honorable mention of FREDERIC P. DEWEY, *West Haven*, and STANLEY FORBES, *San Francisco, Cal.*

For excellence in Mathematics, the prize awarded to HIRAM A. MILLER, *New Haven.*

For excellence in Physics, the prize awarded to HIRAM A. MILLER, *New Haven.*

For excellence in Mechanical Drawing, the prize awarded to GEORGE C. DUNHAM, *Southington.*

ERRATUM.

On page xxxi, line 19, for "September 10," read "September 16."

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PROGRAMME OF STUDIES,

AND

CATALOGUE,

For the College Year 1874--75.

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CALENDAR.

1874.		
10 Sept.	Thursday,	First Term begins.
17 Dec.	Thursday,	First Term ends.
1875.		**Winter Vacation of three weeks.**
7 Jan.	Thursday,	Second Term begins.
8 April,	Thursday,	Second Term ends.
		Spring Vacation of two weeks.
22 April,	Thursday,	Third Term begins.
29 June,	Tuesday,	Meeting of Appointing Board.
29 June,	Tuesday,	Anniversary.
1 July,	Thursday,	Commencement.
2, 3 July,	Friday, Sat.,	Examination for Admission.
		Summer Vacation of eleven weeks.
14, 15 Sept.	Tues.. Wedn.,	Examination for Admission.
16 Sept.	Thursday,	First Term begins.
23 Dec.	Thursday,	First Term ends.

ABBREVIATIONS.

S. H.	Sheffield Hall.
N. S. H.	North Sheffield Hall.
TR.	Treasury Building.
D.	Durfee College.
F.	Farnam College.
S. M.	South Middle College.
D. H.	Divinity Hall.
W. D. H.	West Divinity Hall.

In the buildings belonging to the Sheffield Scientific School, the rooms numbered from 1 to 21 are in Sheffield Hall: from 26 to 58 in North Sheffield Hall.

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'HARD M. BACHE, of the U. S. Coast Survey,
The Use of the Plane Table. 12 Home pl.

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George Watson Smith,	*Chicago, Ill.*	167 Temple st.
LeGrand Smith,	*Chicago, Ill.*	167 Temple st.
George Franklin Taylor,	*Willimantic*,	63 W. D. H.
Francis Augustus Terry,	*Lyme*,	58 W. D. H.
Allan Mason Thomas,	*Wickford, R. I.*	458 Chapel st.
Frederick William Vanderbilt,	*New York City*,	161 Temple st.
Charles Williams Van Vleck,	*Cincinnati, O.*	489 Chapel st.
Thomas Alfred Vernon,	*Brooklyn, N. Y.*	86 W. D. H.
Alfred Elisha Walker,	*Orange*,	85 Church st.
Charles Alexander Watson,	*Hartford*,	156 York st.
David Agnew Weyer,	*Madison, Ind.*	169 Temple st.
David Willard Williams,	*Glastenbury*,	56 W. D. H.
Thomas Yeatman,	*New Haven*,	119 W. D. H.

JUNIORS, 62.

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FRESHMAN CLASS.

William Whittlesey Abbott,	*Yarmouth, Me.*	29 Prospect st.
Shiro Akabane,	*Yedo, Japan,*	11 Grove st.
Alvin Driggs Ayres,	*Woodmont,*	8 Lock st.
Thomas Sanford Beaty,	*Indianapolis, Ind.*	Chapel st.
William Henry Backus,	*Cleveland, O.*	15 Home pl.
George Henry Bartlett,	*North Guilford,*	157 Church st.
Charles Coffing Beach,	*Hartford,*	159 Temple st.
Morris Burke Belknap,	*Louisville, Ky.*	14 Lock st.
Bernard Berens,	*Philadelphia, Pa.*	Chapel st.
Arthur Lewis Betts,	*Norwalk,*	Westville.
Frank Lewis Bidwell,	*Kansas City, Mo.*	533 Chapel st.
Thomas Marcus Blakslee, PH.B. Madison University.	*Hamilton, N. Y.*	324 Elm st.
John Edwards Buddington,	*Huntington,*	Huntington.
David Erwin Burton,	*Erie, Pa.*	134 College st.
Frank Caldwell,	*Carthage, O.*	464 Chapel st.
Joseph Gilbert Calhoun,	*Hartford,*	533 Chapel st.
Thomas Lincoln Casey,	*Washington, D. C.*	464 Chapel st.
Alfred Chapman,	*Bethel,*	104 Grove st.
Clarence Augustus Claflin,	*Hopkinton, Mass.*	458 Chapel st.
Frederick Leonard Cowles,	*New Haven,*	632 Chapel st.
Henry Holbrook Curtis,	*New York City,*	42 Grove st.
Judson Amos Doolittle,	*Cheshire,*	34 York sq. pl.
William Sidney Downs,	*Birmingham,*	119 W. D. H.
Edward Caldwell Earle,	*New Haven,*	214 Orchard st.
Wallace Bruce Fenn,	*New Haven,*	191 Church st.
Burr Kellogg Field,	*Germantown, Pa.*	157 George st.
Joachim John Francke,	*New York City,*	9 Library st.
Allan Murray Gale,	*New Haven,*	87 Trumbull st.
William Edgar Gard,	*Chicago, Ill.*	49 Meadow st.
Charles Cortledge Godfrey,	*Southport,*	41 College st.
William Augustus Goodman,	*Cincinnati, O.*	464 Chapel st.
Cadmus Zaccheus Gordon,	*Brookville, Pa.*	44 York sq. pl.
Henry Sturges Guthrie,	*Buffalo, N. Y.*	50 Trumbull st.
William Jerome Haldeman,	*Cincinnati, O.*	464 Chapel st.
John Elisha Morpeth Hall,	*Brooklyn, N. Y.*	46 York sq. pl.
William Torrence Handy,	*Cincinnati, O.*	221 Elm st.
Atreus Joshua Hargadine,	*St. Louis, Mo.*	7 Library st.
John Philip Henriques,	*New London,*	44 York sq. pl.
Samuel Ferris Hurd Hewit,	*Bridgeport,*	533 Chapel st.
William Stanley Hine,	*Bridgeport,*	Bridgeport.
Walter Holcomb,	*New Hartford,*	29 Prospect st.
William Coe Holmes,	*Waterbury,*	153 Crown st.
Horace Cobb Howard,	*Townsend, Vt.*	105 Park st.
Joseph Paxson Iddings,	*Orange, N. J.*	76 Howe st.

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Charles Maples Jarvis,	*Binghamton, N. Y.*	72 High st.
Clifford Pearse Johnston,	*Lake Forest, Ill.*	167 Temple st.
Frederick Sheldon Judd,	*New Britain,*	12 Trumbull st.
Lawrence Kneeland,	*Brooklyn, N. Y.*	151 Crown st.
George Brewster Laflin,*	*Chicago, Ill.*	114 High st.
Elijah Thien Foh Laisun,	*Shanghai, China,*	226 Church st.
Frank Cooper Lawrance,	*New York City,*	488 Chapel st.
Alton Winslow Leighton,	*New Haven,*	137 Henry st.
Charles James Luck,	*Rouse's Point, N. Y.*	34 York sq. pl.
Arthur Martin,	*Orange, N. J.*	76 Howe st.
Ferrier John Martin,	*Orange, N. J.*	76 Howe st.
Frank Peterson Mitchell,	*Cincinnati, O.*	109 Elm st.
Charles Knox Mixter,	*Rock Island, Ill.*	16 Ashmun st.
Charles Arthur Montjoy,	*Lambayeque, Peru,*	15 Home pl.
James Blair Murray,	*Norwich,*	35 High st.
Samuel Lewis Penfield,	*Catskill, N. Y.*	193 Temple st.
William Francis Pier,	*Scranton, Pa.*	223 Elm st.
Henry Brooks Plumb,	*Terryville,*	533 Chapel st.
Willard Nourse Pratt,	*Elmira, N. Y.*	26 Tremont House.
Francis Rawlinson Read,	*Hartford,*	759 Chapel st.
George Francis Reynolds,	*New Haven,*	129 York st.
James Tracey Richards,	*Stratford,*	69 W. D. H.
Theodore William Riley,	*Scranton, Pa.*	223 Elm st.
Lucius Waterman Robinson,	*Fair Haven,*	225 Ferry st.
Thomas Weaver Rogers,	*Brooklyn, N. Y.*	8 Lock st.
Thomas Fitch Rowland,	*Greenpoint, N. Y.*	92 Chapel st.
Everett Rushmore,	*Mamaroneck, N. Y.*	147 York st.
William Thompson Sedgwick,	*Farmington,*	4 Library st.
Charles Dwight Smith,	*Plantsville,*	29 Prospect st.
George Smith,	*New Haven,*	164 Elm st.
Walter Snowdon Smith,	*Cincinnati, O.*	464 Chapel st.
George Elias Squires,	*East Haddam,*	202 Grand st.
Frederic Taintor,	*Hampton,*	167 Temple st.
Henry Ling Taylor,	*New York City,*	462 Chapel st.
Arthur John Tenney,	*New Haven,*	126 Crown st.
William Gilman Thompson,	*New York City,*	120 College st.
John Abeel Weekes,	*New York City,*	84 Wall st.
George Kellogg Welch,	*Hartford,*	167 Temple st.
Horace Lemuel Wells,	*New Britain,*	12 Trumbull st.
William Russell White,	*Danbury,*	41 High st.
Albert Daniel Wilson,	*Newburgh, N. Y.*	81 Wall st.
George Leverett Wilson,	*West Killingly,*	85 Bradley st.
Edwin Young,	*Honesdale, Pa.*	84 Wall st.
William Hopkins Young,	*Poughkeepsie, N. Y.*	85 Wall st.
Lemuel Yung,	*Macao, China,*	58 Temple st.

FRESHMEN, 89.

* Deceased.

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SPECIAL STUDENTS NOT CANDIDATES FOR A DEGREE.

Samuel Forbes Adam,	*Canaan*,	64 W. D. H.
Charles Edwin Bogue,	*Crown Point, N. Y.*	41 College st.
Thomas Attwater Bostwick,	*New Haven*,	162 Olive st.
Russell Henry Chittenden,	*New Haven*,	23 Humphrey st.
Samuel Fessenden Clark,	*Geneva, Ill.*	58 N. S. H.
Franklin Wilson,	*Killingworth*,	14 Park st.
Clinton Hart Merriam,	*Locust Grove, N. Y.*	42 Whitney av.
William H. Osborne,	*Georgetown*,	85 Bradley st.
Herbert John Russell, Worcester Free Institute,	*Worcester, Mass.*	133 Dwight st.
William Oakley Wallace,	*Ansonia*,	525 Chapel st.
Henry Ellsworth Wood, CH.	*Joliet, Ill.*	8 Trumbull st.

SPECIAL STUDENTS, 11.

SUMMARY.

GRADUATES,	31
SENIORS,	56
JUNIORS,	62
FRESHMEN,	89
SPECIAL STUDENTS,	11
TOTAL,	249

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SHEFFIELD SCIENTIFIC SCHOOL.

I.

Objects.

THE SHEFFIELD SCIENTIFIC SCHOOL is devoted to instruction and researches in the mathematical, physical, and natural sciences, with reference to the promotion and diffusion of science, and also to the preparation of young men for such pursuits as require especial proficiency in these departments of learning. It is one of the Departments of Yale College, like the law, medical, theological, and art schools, having its separate funds, buildings, teachers, and regulations, but governed by the Corporation of Yale College, which appoints the professors and confers the degrees. It is, in part, analogous to the academic department or classical college, and, in part, to the professional schools.

The instruction is intended for two classes of students:—

I. Graduates of this or of other Colleges, and other persons qualified for advanced or special scientific study.

II. Undergraduates who desire a training chiefly mathematical and scientific, in less part linguistic and literary, for higher scientific studies, or for various other occupations to which such training is suited.

II.

History and Organization.

The School was commenced in 1847. In 1860, a convenient building and a considerable endowment were given by Joseph E. Sheffield, Esq., of New Haven, whose name, at the repeated request of the Corporation of Yale College, was afterward attached to the foundation. Mr. Sheffield has since frequently and munificently increased his original gifts.

In 1864, by an act of the Connecticut Legislature, the national grant for the promotion of scientific education (under the congressional enactment of July, 1862) was given to this department of Yale College, which thus became "the College of Agriculture and the Mechanic Arts for Connecticut." Since that time, and

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especially since the autumn of 1869, numerous liberal gifts have been received from the citizens of New Haven, and from other gentlemen in Connecticut, New York, and St Louis, for the endowment of the School, and the increase of its collections.

The action of the State led to the designation by law of a State Board of Visitors, consisting of the Governor, Lieutenant-Governor, three senior Senators, and the Secretary of the State Board of Education; and this Board, with the Secretary of the Scientific School, is also the Board for the appointment of students to hold the State scholarships.

At the request of the Governing Board, the Corporation of Yale College has also appointed a Board of Councillors for the School, consisting of a number of gentlemen who have taken a deep interest in its welfare.

The Governing Board consists of the President of Yale College and the Professors who are permanently attached to the School. There are several other instructors associated with them, a part of whom are connected with other departments of the College.

III.

Building and Apparatus.

The two buildings in which the work of instruction in the Scientific School is carried on are called Sheffield Hall and North Sheffield Hall. These contain a large number of recitation and lecture rooms, a hall for public assemblies and lectures, chemical and metallurgical laboratories, a photographical room, an astronomical observatory, museums, a library and reading room, besides studies for some of the professors, where their private technical libraries are kept.

The following is a summary statement of the collections belonging to the School:—

1. Laboratories and Apparatus in Chemistry, Metallurgy, Physics, Photography, and Zoölogy.
2. Metallurgical Museum of Ores, Furnace Products, etc.
3. Agricultural Museum of Soils, Fertilizers, useful and injurious insects, etc.
4. Collections in Zoölogy.
5. Astronomical Observatory, with an equatorial telescope by Clark and Sons of Cambridge, a meridian circle, etc.
6. A collection of Mechanical Apparatus, constituting the "Collier Cabinet."
7. Models in Architecture, Geometrical Drawing, Civil Engineering, Topographical Engineering, and Mechanics; diagrams adapted to public lectures; instruments for field practice.

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8. Maps and Charts, topographical, hydrographical, geological, etc.

The mineralogical cabinet of Professor Brush, the herbarium of Professor Brewer, the collection of native birds of Professor Whitney, and the astronomical instruments of Professor Lyman, are deposited in the building. Professor Eaton's herbarium, near at hand, is freely accessible.

Students are also admitted, under varying conditions, to the College and Society libraries, the College Reading Room, the Cabinet of Minerals and Fossils, the School of the Fine Arts, and the Gymnasium.

IV.

The Library.

The special technical library of the Scientific School consists of about five thousand volumes. Included in this is the "Hillhouse Mathematical Library" of twenty-four hundred volumes, collected during a long series of years by Dr. William Hillhouse, and five years ago purchased and presented to the Institution by Mr. Sheffield. A Catalogue of this collection forms a supplement to the Annual Report of the Governing Board for 1870.

The following scientific journals are received regularly at the Library, and are accessible to all for consultation.

AMERICAN.

Journal of the Franklin Institute.
Engineering and Mining Journal.
Scientific American.
Mining and Scientific Press.
Van Nostrand's Eclectic Engineering Magazine.
Railroad Gazette.
Bulletin of the National Association of Wool Manufacturers.
American Chemist.
American Journal of Science.

ENGLISH.

Agricultural Gazette, The.
Annals and Magazine of Natural History.
Builder, The.
Economist, The.
Engineer, The.
Engineering.
Farmer's Magazine.
Garden, The.
Gardiner's Chronicle, The.
Grevillea.
Iron.
Journal of the Anthropological Institute.
——— of the Chemical Society.

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Journal, Quarterly, of Microscopical Science.
——— Quarterly, of Pure and Applied Mathematics.
——— Quarterly, of Science.
Magazine, The Botanical.
Mining Journal, The.
Monthly Notices of the Royal Astronomical Society.
Nature.
News, The Chemical, and Journal of Physical Science.
Philosophical Magazine, The London, Edinburgh, and Dublin.

FRENCH.

Annales de Chimie et de Physique.
——— Nouvelles de la Construction.
——— des Ponts et des Chaussées.
Archives de Zoölogie Experimentale et Generale.
Bulletin de la Société de Géographie.
——— de Société Chimique.
Connaisance des Temps.
Journal d'Agriculture Pratique.
——— de Zoologie.
Mémoires de la Société d'Anthropologie de Paris.
Mondes, Les.
Revue Scientifique.
——— Universelle des Mines.
Technologiste, Le.

GERMAN.

Annalen der Landwirthschaft.
——— der Physik und Chemie.
Archiv für Anthropologie.
Berichte der Deutschen Chemischen Gesellschaft.
Centralblatt Chemisches.
——— Polytechnisches.
Civil-Ingenieur, Der.
Hedwigia.
Jahrbuch, Berliner Astronomisches.
——— über die gesammten Fortschritte der Mathematik.
Journal für praktische Chemie.
——— für reine und angewandte Mathematik.
Landwirthschaftliche Jahrbücher.
Milch-Zeitung.
Nachrichten, Astronomische.
Polytechnisches Journal, Dingler's.
Repertorium für Experimental-Physik, etc.
Zeitschrift für Biologie.
——— für Analytische Chemie.
——— für Math. und Naturw. Unterricht.
——— für Wissenschaftliche Zoologie.
Zeitung, Berg-und Hüttenmännische.
——— Botanische.

Niederländisches Archiv für Zoologie.

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Numerous scientific journals, not included in this list, can be found in the private libraries of various professors, which are deposited in the building, and are accessible for consultation; and in the College library there are a much larger number of others, especially of the proceedings of foreign academies and scientific societies.

V.

Instruction for Graduate and Special Students.

Persons who have gone through undergraduate courses of study, here or elsewhere, may avail themselves of the facilities of the School for more special professional training in the physical sciences and their applications, gaining in one, two, or three years the degree of BACHELOR OF PHILOSOPHY, or, in two additional years of Engineering study, that of CIVIL ENGINEER, or of DYNAMICAL ENGINEER.

Or, engaging in studies of a less exclusively technical character, they may become candidates for the degree of DOCTOR OF PHILOSOPHY. The instruction in such cases will be adapted to the particular needs and capacities of each student, and may be combined with that given by the graduate instructors in other departments of the University. This degree is conferred upon those who, having already taken a Bachelor's degree, engage as students in the Department of Philosophy and the Arts for not less than two years in assiduous and successful study. It is not given upon examination to those whose studies are pursued elsewhere. The requirements for it will in some cases exact of the student more than two years of post-graduate labor; so, especially, wherever the course of undergraduate study has been, as in the Scientific School, of less than four years. The candidate must pass a satisfactory final examination, and present a thesis giving evidence of high attainment in the branches of knowledge to which he has attended. A good knowledge of Latin, German and French will be required in all cases, unless, for some exceptional reason, the candidate be excused by the Faculty. The graduating fee is ten dollars.

Subjects likely to receive special attention are suggested as follows:—

Professor NORTON will instruct in applied mechanics and in spherical astronomy.

Professor LYMAN, in the use of meridional and other astronomical instruments, and in astronomical spectroscopy.

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Professor TROWBRIDGE, in the principles of thermodynamics, and utilization of heat as a source of power.

Professor BRUSH, in the analysis and determination of mineral species, and in descriptive mineralogy.

Professor JOHNSON, in theoretical, analytical, and agricultural chemistry.

Professor BREWER, in agriculture and forest culture, in the use of the microscope, and in physical geography.

Professor CLARK, in definite integrals, differential equations, analytical mechanics, the theory of numerical approximations, and the method of least squares.

Professor EATON, in structural and systematic botany, including the North American flora and the description of genera and species.

Professor MARSH, in palæontology and comparative osteology.

Professor WALKER, in public finance and in the statistics of industry.

Professor ALLEN, in analytical chemistry, and in metallurgy.

Professor VERRILL, and Mr. S. I. SMITH, in zoölogy and geology.

The same courses of study are open, for a longer or shorter time, to graduate students who do not desire to become candidates for a degree.

Students who have taken the degree of Bachelor of Philosophy, may obtain the degree of CIVIL or of DYNAMIC ENGINEER at the end of two academical years, by pursuing the following higher course of study and professional training.

The course of study for the degree of CIVIL ENGINEER will comprise

1. Higher Calculus. Higher Geometry. Theory of Numerical Operations.
2. Analytical Mechanics. Mechanics applied to Engineering.
3. A Course of Construction and Design. Projects.
4. Practical Astronomy, with use of instruments, computations, etc.

This course will occupy three academical terms.

To secure the requisite amount of professional knowledge and practice, the candidate will be required to furnish a comprehensive report of the results of an examination into the existing condition of some special line of constructive art; or to present proper evidence that he has had actual charge in the field, for several months, of construction or surveying parties, or held some responsible position deemed equivalent to this.

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An elaborate design must also be submitted of some projected work of construction, based upon exact data obtained from careful surveys made by the candidate, and comprising all the requisite calculations, and the necessary detailed drawings, and accompanied by full specifications of the work to be done, and the requirements to be met by the contractor.

The fee for this degree is five dollars.

The course of study for the degree of DYNAMICAL ENGINEER will comprise

1. Higher Calculus, General Theory of Equations and of Numerical Operations.
2. General Principles of Dynamics (Analytical Mechanics). Including special application of these principles to Dynamical problems.
3. Construction of Machines. Designs.
4. Preparation of theses on special subjects in Dynamic Engineering.

During the second year candidates will be permitted to employ such a portion of their time as may be deemed advisable or necessary in the examination of engineering works and manufacturing establishments, and may also have the privilege of entering upon professional practice, provided it is done with the knowledge and consent of the Professor of Dynamic Engineering, and under such circumstances as shall appear to him to be favorable to professional progress.

An elaborate thesis on some professional subject, with an original design, or project, accompanied by proper working drawings, will be required at the end of the second year.

The fee for this degree is five dollars.

SPECIAL STUDENTS.—For the benefit of those who, being fully qualified, desire to pursue particular studies without reference to the obtaining of a degree, special or irregular students are received in most of the departments of the School; not, however, in the Select Course or in the Freshman Class.

It should be distinctly understood that these opportunities are not offered to persons who are incompetent to go on with regular courses, but are designed to aid those who, having received a sufficient preliminary education elsewhere, desire to increase their proficiency in special branches.

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VI.

Requirements for Admission.

TERMS OF ADMISSION.—Candidates must be not less than sixteen years of age, and must bring satisfactory testimonials of moral character from their former instructors or other responsible persons.

For admission to the Freshman Class the student must pass a thorough examination in the following subjects:

English Grammar—including spelling and composition.
History of the United States.
Geography.
Latin—Six books of Cæsar's commentaries or their equivalent, and simple exercises in prose composition.

Arithmetic—including the Metric System.
Algebra—Davies' Bourdon, or Loomis's Treatise, as far as the general theory of equations; or an equivalent.
Geometry—the nine books of Davies' Legendre, or the ten books of Loomis' Elements; or an equivalent.
Plane Trigonometry—the solution of Plane Triangles and the Trigonometrical Formulæ contained in Davies' Legendre, or Loomis's Trigonometry.
(In Geometry, in the examinations of 1876, Chauvenet's Geometry, or an equivalent, will be required. In the examinations of 1877, Snowball and Lund's Course of Elementary Natural Philosophy* will be required.)

The examinations for admission take place at North Sheffield Hall, on Friday and Saturday, July 2, 3; and on Tuesday and Wednesday, September 14, 15, 1875. Opportunity for private examination may, in exceptional cases, be given at other times.

Candidates for advanced standing in the undergraduate classes are examined, in addition to the preparatory studies, in those already pursued by the class they propose to enter. No one can be admitted as a candidate for a degree later than at the beginning of the Senior year.

For the guidance of students purposing to enter this institution, the following information is furnished in regard to the requirements in certain studies; not necessarily because the subjects mentioned are of any more importance in themselves, but because experience has shown that they are the subjects in which candidates are generally apt to be to a greater or less extent deficient.

* Published by Macmillan & Co., London and New York.

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Arithmetic.—The examination in this study will embrace the leading topics taught in the high schools of the country. It will extend to the rationale of arithmetical processes as well as to the processes themselves; and candidates should, therefore, have carefully reviewed the subject, after having attained sufficient maturity to comprehend it.

Algebra.—The following subjects will receive special attention in the examination in this branch:

The fundamental operations upon both entire and fractional expressions, including factoring; the solution of equations of the first and second degrees; the reduction of inequalities; the theory of fractional and negative exponents, and the calculus of radicals; the application of the binomial formula, whatever be the exponent; the method of indeterminate co-efficients; and the theory and use of logarithms. There is far too often a general want of thoroughness in the preparation of candidates in this fundamental branch of mathematical analysis.

Geometry.—In this subject the candidate should have in his preparation a sufficient number of not too difficult exercises in geometrical invention, such as can be chosen from the works of Loomis, Chauvenet, Tappan, and Olney, and further found in abundance in various English and other foreign collections. Particular attention should also be paid to exercises in the elementary formulæ of mensuration.

Trigonometry.—In Trigonometry it is absolutely requisite that the candidate make himself thoroughly familiar with the deduction of the formulæ, with the use of the trigonometrical tables, and the solution of plane triangles. He should besides be exercised as far as practicable in simple trigonometrical transformations. Todhunter's "Trigonometry for Beginners" will furnish abundant material for this class of exercises. In his trigonometrical calculations, as in all others, he should study the art of neat and orderly arrangement, as an important means to a valuable end. If the use of logarithms is postponed till trigonometry is taken up (which is by no means advisable), it should embrace all forms of calculation occurring in ordinary practice, as well as those appearing in the solution of triangles; since any one of the former is liable at any time to appear in the work given in the examinations.

Latin.—In order to assure the attainment of the desired proficiency in this study, the student should have such continued

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training in parsing as shall make him thoroughly familiar with declension and conjugation, and accurate and ready in the application of the rules of syntax. It will also contribute greatly to the mastery of these grammatical elements, if the practice of translating from English into Latin, both orally and in writing, be methodically pursued. The deficiencies frequently manifested at examination could seldom exist, if this double system of parsing and of translation into Latin were more generally followed. A knowledge of prosody will not be required.

VII.

Instruction for Undergraduate Students.

COURSES OF INSTRUCTION, occupying three years, are arranged to suit the requirements of various classes of students. The first year's work is the same for all; during the last two years the instruction is chiefly arranged in special courses.

The special courses most distinctly marked out are the following:—

(a.) In Chemistry;
(b.) In Civil Engineering;
(c.) In Dynamic (or Mechanical) Engineering;
(d.) In Agriculture;
(e.) In Natural History;
(f.) In studies preparatory to Medical Studies;
(g.) In studies preparatory to Mining and Metallurgy;
(h.) In Select studies preparatory to other higher studies.

The arrangement of the studies is indicated in the annexed scheme.

FRESHMAN YEAR.—INTRODUCTORY TO ALL THE COURSES.

FIRST TERM.—*German*,—Whitney's Grammar and Reader. *English*,—Hadley's Brief History of the English Language; Exercises in Composition. *Mathematics*,—Plane Analytical Geometry. *Physics*,—Atkinson's Ganot, with experimental lectures. *Chemistry*,—Eliot and Storer's Manual: Laboratory practice. *Elementary Drawing*,—Practical Lessons in the Art School.

SECOND TERM.—*Language, Physics, Chemistry, and Drawing*,—As stated above. *Mathematics*,—Elements of the Theory of Numerical Approximations; Solution of Higher Numerical Equations; Methods of Interpolation. *Physical Geography*,—Lectures.

THIRD TERM.—*German and Physics*,—As stated above. *Mathematics*,—Analytical Geometry in Space; Spherical Trigonometry. *Botany*,—Gray's Lessons. *Polit. Economy*,—Elementary Lectures. *Drawing*,—Orthographic Projection.

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For the Junior and Senior years the students select for themselves one of the following courses:—

(a.) IN CHEMISTRY.

JUNIOR YEAR.

FIRST TERM.—*Theoretical and Organic Chemistry*,—Lectures. *Qualitative Analysis*,—Fresenius. *Laboratory Practice. Blowpipe Analysis. German. French.*

SECOND TERM.—*Laboratory Practice*,—Qualitative Analysis, continued. Quantitative Analysis, begun. *Mineralogy*,—Blowpipe Analysis and Determination of Species. *Zoology*,—Lectures. *German. French.*

THIRD TERM.—*Laboratory Practice*,—Quantitative Analysis, continued. *Mineralogy*,—Lectures. *Zoology*,—Lectures and Excursions. *German. French.*

SENIOR YEAR.

FIRST TERM.—*Laboratory Practice*,—Volumetric and Organic Analysis. *Geology*.—Dana's. *Zoology*,—Lectures. Excursions. *French.*

SECOND TERM.—*Laboratory Practice*,—Mineral Analysis and Assaying. *Agricultural Chemistry*,—Recitations and Lectures (optional). *Geology*,—Dana's. *Metallurgy* (optional). *French. Zoology*,—Lectures.

THIRD TERM.—*Laboratory Practice.* Preparation of Thesis. *Agricultural Chemistry*,—Lectures (optional). *Geology*,—Dana's. *Metallurgy* (optional). *Mineralogy* (optional). *French. Zoology*,—Lectures.

(b.) IN CIVIL ENGINEERING.

JUNIOR YEAR.

FIRST TERM.—*Mathematics*,—Differential and Integral Calculus. Descriptive Geometry. *Surveying*,—Field Operations. *Drawing*,—Binns' Orthographic Projections. *German. French.*

SECOND TERM.—*Mathematics*,—Integral Calculus. Rational Mechanics. *Drawing*,—Projection of Shadows and Perspective. *German. French.*

THIRD TERM.—*Mathematics.* Rational Mechanics. Descriptive Geometry. Warped Surfaces. *Surveying*,—Topographical. *Drawing*,—Topographical. *German. French.*

SENIOR YEAR.

FIRST TERM.—*Field Engineering*,—Laying out Curves. Location of line of Railroad, with calculations of Excavation and Embankment. Hencks' Field Book for Railroad Engineers. *Civil Engineering*,—Mahan's. *Stone Cutting*,—with graphical problems. *Geology*,—Dana's. *Mineralogy*,—Blowpipe Analysis and Determinative Mineralogy. *Drawing*,—Architectural and Structural. *French.*

SECOND TERM.—*Civil Engineering*,—Resistance of Materials. Bridges and Roofs. Building Materials. *Astronomy*,—Loomis's Astronomy, with practical problems. *Mineralogy*,—continued. *Geology*,—Dynamic. *French.*

THIRD TERM.—*Civil Engineering*,—Bridges and Roofs. Stability of Arches and Walls. *Dynamics*,—Principles of Mechanism. Steam Engine. *Hydraulics*,—Hydraulics and Hydraulic Motors.

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(c.) IN DYNAMICAL ENGINEERING.

JUNIOR YEAR.

FIRST TERM.—*Mathematics.* Differential and Integral Calculus. Descriptive Geometry. *Instrumental Drawing. German. French.*

SECOND TERM.—*Mathematics.* Integral Calculus. Rational Mechanics. *Instrumental Drawing. German. French.*

THIRD TERM.—*Mathematics.* Rational Mechanics. *Drawing.* Binns' Second Course, including drawing of gearing, perspective, shades and shadows, tinting, construction of warped surfaces, and isometric drawing. *German. French.*

SENIOR YEAR.

FIRST TERM.—*Drawing,*—Construction of Machines from actual measurements in the shops. *General Theory of Motion,*—Applications of this theory to the motions of bodies, and to the motions of parts of machines. *General Theory of Gearing,*—Cams, connections by bands, links, cords, and hydraulic connections. General principles of trains of mechanism. Mechanical powers. Aggregate combinations in mechanism (Rankine). *Theory of Valve Motions* (Zeuner). *Applied Mechanics,*—Machinery and mill work. Dynamics of Machinery (Rankine), commenced. *French. Geology.*

SECOND TERM.—*Applied Mechanics,*—continued. *Dynamics of Machinery,*—Theory of Machines.—Special applications of the Theory of Machines to problems involving the efficiency of machines and to special machines. *Materials used in construction,* their composition and qualities, iron, steel, alloys, wood, animal substances. Drawing (construction of machines), continued. *Theory of Elasticity,*—Principles of construction of roof-trusses, beams, girders, and bridges. Principles relating to resistance to torsion of shafts, to shearing, and to stiffness and stability of structures. (Rankine.) *Heat,*—General principles. Application of principle of specific heat. Action of bodies under the influence of heat. Change of states of aggregation. Expansion. Applications of law of Mariotte and Gay Lussac. Gases. Vapors. Laws of expansion. Densities. Elastic force of gases and vapors. Quantities of heat. Latent heats of fusion and evaporation. *Combustion,*—Quantities of air required, nature of products, heat evolved. *Fuel,*—Kinds and quantities, Transfer of heat. *Description of Steam Generators,*—Principles of construction of steam generators. *Geology. French.*

THIRD TERM.—*Prime Movers in General,*—Animal mechanics, water powers, heat engines, regulators, dynamometers, valves, brakes, fly-wheels, governors, measurement of friction, &c. *Water Power Engines,*—Sources of water power, measurement of supply. Construction of conduits. Measurements of flow. Hydraulic press. Water pressure engines. *Water Wheels,*—Overshot, undershot and breast wheels. Reaction wheels. Turbine wheels. Wind power. *Heat Engines.*—Principles of thermodynamics. Air engines. Steam engines. Efficiency of steam and air engines. Mechanism of steam and air engines. Drawing of structures. *Metallurgy.*

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(d.) IN AGRICULTURE.

JUNIOR YEAR.

FIRST TERM.—*Theoretical and Organic Chemistry.*—Lectures. *Experimental and Analytical Chemistry,*—in their Agricultural applications. Laboratory Practice. *Physical Geography. Mineralogy,*—Blowpipe Analysis and Determinative Mineralogy. *English. German. French.*

SECOND TERM.—*Agricultural Chemistry,*—Recitations. *Experimental Chemistry,*—Laboratory Practice. *Physical Geography. Mineralogy.* Lectures. *English. German. French.*

THIRD TERM.—*Agricultural Chemistry,*—Lectures. *Horticulture and Kitchen Gardening,*—Lectures. *Experimental Chemistry,*—Laboratory Practice. *Botany and Zoology,*—with Excursions. *Mineralogy,*—continued. *English. German. French.*

SENIOR YEAR.

FIRST TERM.—*Agriculture,*—Cultivation of the Staple Crops of the Northern States. *Agricultural Zoology,*—Origin and Natural History of Domestic Animals. Insects useful and injurious to Vegetation. *Geology,*—Dana's. *English. French. Excursions,*—Agricultural, Botanical, etc.

SECOND TERM.—*Agriculture,*—Stock raising and principles of Breeding. *Geology,*—Dana's. *Human Anatomy and Physiology,*—Lectures. *English. French.*

THIRD TERM. *Rural Economy,*—History of Agriculture and Sketches of Husbandry in Foreign Countries. Systems of Husbandry. *Geology,*—Dana's. *English.*

(e.) IN NATURAL HISTORY.

(Either Geology, Mineralogy, Zoology, or Botany may be made the principal study, some attention in each case being directed to the other three branches of Natural History.)

JUNIOR YEAR.

FIRST TERM.—*Chemistry,*—Qualitative Analysis. Laboratory Practice. Recitations. *Mineralogy,*—Blowpipe Analysis and Determinative Mineralogy. *Botany,*—Gray's Text-Book; Use of the Microscope. *German. French.*

SECOND TERM.—*Zoology,*—Laboratory Practice. *Physiology,*—Huxley's. *Botany,*—Laboratory Practice; Gray's Text-Book. *Mineralogy,*—Lectures. *Physical Geography. German. French.*

THIRD TERM.—*Zoology,*—Laboratory Practice. Lectures, Excursions (land and marine). *Anatomy of Vertebrates,*—Huxley's. *Botany,*—Practical Exercises, Excursions. *Mineralogy,*—continued. *German. French.*

SENIOR YEAR.

FIRST TERM.—*Geology,* Dana's. Excursions. *Zoology,*—Laboratory Practice. Lectures. Excursions. *Botany,*—Herbarium Studies. Excursions. *Linguistics,*—Whitney's Language and the Study of Language. *French.*

SECOND TERM.—*Geology,*—Dana's. *Zoology*—Laboratory Practice. Excursions. *Botany,*—Herbarium Studies. Botanical Literature. Essays in Descrip-

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tive Botany. *Linguistics*,—Whitney's Language and the Study of Language. *French.*

THIRD TERM.—*Geology, Zoology, and Botany*—continued, with Excursions. *Meteorology. French.*

Besides the regular courses of recitation and lectures on structural and systematic Zoology and Botany, and on special subjects, students are taught to prepare, arrange, and identify collections, to make dissections, to pursue original investigations, and to describe Genera and Species in the language of science. For these purposes, large collections in Zoology and Palæontology belonging to the College are available, as are also the private botanical collections of Professor Eaton.

(f.) IN PREPARATION FOR MEDICAL STUDIES.

During the Junior year, the work of this course will be chiefly under the direction of the instructors in Chemistry. Especial attention will be given to qualitative and quantitative analysis, in their physiological and medical bearings; and to the preparation and study of the organic proximate elements. In the Senior year, the work will be chiefly under the direction of the Professors of Zoology and Botany. Attention will be paid in Zoology to comparative anatomy, embryology, the laws of hereditary descent, and human parasites; and in Botany to a general knowledge of structural and physiological Botany, and to medicinal, food-producing, and poisonous plants. The order of studies is as follows:

JUNIOR YEAR.

FIRST TERM.—*Chemistry*,—Qualitative Analysis, Fresenius'. Laboratory Practice. Recitations. *Mineralogy*,—Blowpipe Analysis and Determinative Mineralogy. *German. French.*

SECOND TERM.—*Physiological Chemistry*,—Klein's Handbook. Laboratory Practice. Recitations. *Physiology*,—Huxley's. *Mineralogy*,—continued. *German. French.*

THIRD TERM.—*Physiological Chemistry*,—Klein's. Laboratory Practice. Recitations. *Zoology*,—Lectures and Excursions. *Botany*,—Lectures, Practical Exercises and Excursions. *Mineralogy*,—continued. *German. French.*

SENIOR YEAR.

FIRST TERM.—*Comparative Anatomy and Physiology*,—Laboratory Practice. *Anatomy of Vertebrates*,—Huxley's. *Botany*,—Practical Exercises, Lectures, and Excursions. *Geology*,—Dana's. *Zoology*,—Lectures and Excursions. *French.*

SECOND TERM.—*Comparative Anatomy and Systematic Zoology*,—Lectures. Laboratory Practice. *Botany*,—Lectures. Laboratory Practice. *Geology*,—Dana's, *French.*

THIRD TERM.—*Comparative Anatomy and Physiology*,—Laboratory Practice. *Zoology, Botany and Geology*—continued, with Excursions.

(g.) IN STUDIES PREPARATORY TO MINING AND METALLURGY.

Young men desiring to become Mining Engineers, can pursue the regular course in Civil or Mechanical Engineering, and at its close can spend a fourth year in the study of metallurgical chemistry, mineralogy, etc.

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(h.) IN THE SELECT STUDIES PREPARATORY TO OTHER HIGHER STUDIES.

JUNIOR YEAR.

FIRST TERM.—*Mineralogy*,—Blowpipe Analysis and Determinative Mineralogy. *Astronomy. Physical Geography. English*,—Langland's Vision of Piers Plowman, and Chaucer. *History*,—Freeman's Outlines. *French. German.*

SECOND TERM.—*Mineralogy*,—Lectures. *Astronomy. Physical Geography. English*,—Chaucer, Shakespeare. *History*,—Freeman's Outlines, with Lectures. *German. French.*

THIRD TERM.—*Botany and Zoology*,—Lectures and Excursions and Laboratory Practice. *English*,—Shakespeare. *Political Economy*,—Walker's Science of Wealth. *German. French.*

SENIOR YEAR.

FIRST TERM.—*Geology*,—Recitations and Excursions. *Botany*,—Lectures, Excursions and Laboratory Practice. *Zoology*,—Lectures and Excursions. *Linguistics*,—Whitney's Language and the Study of Language. *English*,—Shakespeare. *History*,—Constitutional History of the United States. Lectures. *Political Economy*,—Lectures. *French.*

SECOND TERM.—*Geology and Zoology*,—continued. *Linguistics*,—Whitney's Language and the Study of Language. *Political Economy*,—Lectures. *English*,—Shakespeare and Milton. *History*,—Political History of the United States. Lectures. *French.*

THIRD TERM.—*Geology*,—Recitations and Excursions. *Zoology*,—Lectures. *Meteorology. English*,—Dryden and Pope. *History*,—Lectures. History of Europe since 1848. *Political Economy*,—Lectures.

Exercises in English Composition are required during the entire course from all the students. The preparation of graduating theses is among the duties of the Senior year.

Lectures on Military Science and Tactics are annually given.

Drawing.

The course in drawing extends through the three years. During the first term and half of the second term of Freshman year, the students practice free-hand drawing at the Art School building, under the direction of Professor Niemeyer, of the Yale School of the Fine Arts. After the completion of the course in free-hand drawing, instruction is given by Mr. F. R. Honey, during the second half of the year, in the elementary principles of instrumental drawing, embracing the whole of Binns' first course of orthographic projections. This course is obligatory upon all.

During the Junior and Senior years, instruction in drawing is obligatory only on the students in Civil and Mechanical Engin-

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eering. In the former year the system of instruction embraces Binns' second course in orthographic projections, isometric drawing, shades and shadows, tinting, perspective, and warped surfaces. By this method all the problems in Descriptive Geometry are required to be worked out on the drawing-board instead of the black-board. The course extends through the entire year, and is under the direction of Mr. Honey.

In Senior year, students are required to apply the principles of drawing already obtained to works of construction, under the general supervision of the Professors of Civil and of Dynamic Engineering.

VIII.

Methods of Instruction.

The instructions of this institution are given chiefly in small class rooms, recitations or familiar lectures, illustrated by the apparatus at the command of the various teachers. In many studies weekly excursions are made for the purpose of collecting specimens and examining natural phenomena.

In Chemistry and Metallurgy the students work several hours daily in well appointed laboratories, under the direct superintendence of the instructors, and are guided through systematic courses of quantitative and qualitative analysis, assaying, and the blow-pipe determination of minerals and ores.

In Botany, during the summer of Junior year, exercises in analyzing and identifying plants occur two or three times a week, followed by practice in writing characters and descriptions of plants from living specimens. Students are shown also the best methods of collecting and preserving for future study, specimens of Flowering Plants, Ferns, Mosses, Algæ, &c. In the autumn term of Senior year the work of the summer is continued. Students are encouraged to pursue special lines of Botanical investigation, and varied assistance is rendered them according to their needs. The final examination is intended to show what they have learned, and the collections they have made are considered to be of minor importance.

In Zoology weekly excursions are made during the third term of Junior and first term of Senior year, in company with the instructors, for the purpose of observing the habits and making collections of marine, fresh-water, and terrestrial animals of all classes. Each student is required to prepare and present for

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examination a collection containing a specified number of species, and illustrating the various classes of animals. He must also be able to pass an examination upon his collection, at least to the extent of explaining the classes and orders illustrated, and showing why particular specimens belong to the respective classes.

In Geology excursions are made for the purpose of examining geological phenomena and making special collections of rocks and minerals. Each student is required to pass a satisfactory examination on his collections at the end of the first term of Senior year.

In addition to the above, a course of lectures is given every winter by the professors of the school and others, on topics of popular interest.

IX.

Tuition Charges.

The charge for tuition is $150 per year, payable, $55 at the beginning of the first and of the second term, and $40 at the beginning of the third term. The special student of Chemistry has an additional charge of $70 per annum for chemicals and use of apparatus. He also supplies himself at his own expense with gas, flasks, crucibles, etc., the cost of which should not exceed $10 per term. A fee of $5 is charged members of the Freshman Class for chemicals and materials used in their laboratory practice, and the same fee is required from all who take the practical exercises in Blow-pipe Analysis and Determinative Mineralogy. An additional charge of $5 is annually made to each student for the use of the College Reading Room and Gymnasium.

X.

Church Sittings.

Free sittings for students in this department of Yale College are provided as follows:

In the Center Church (Cong.): Pews Nos. 36 and 42, in the North Gallery.

In Trinity Church (Episc.): Pews Nos. 175 and 177, in the North Gallery.

In the First Methodist Church: Pew No. 78, at the head of the West Aisle (below).

Any of the students may occupy a sitting in these slips. Those who prefer to pay for a sitting for a year, more or less, in the

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churches above mentioned, or in any other church of any denomination, will be aided on application to the Secretary of School.

Sittings in the Gallery of the College Chapel are free as heretofore to the students of this department.

XI.

Degrees.

Students of this department, on the recommendation of the Governing Board, are admitted by the Corporation of Yale College to the following degrees. They are thus conferred:

1. Bachelor of Philosophy: on those who complete any of the three-year courses of study, passing all the examinations in a satisfactory manner, and presenting a graduation thesis.

The fee for graduation as Bachelor of Philosophy, including the fee for Triennial Catalogues, Commencement Dinners, etc., is ten dollars; unless the person taking the degree is also an academical graduate, when it is but five dollars.

2. Civil Engineer and Dynamical Engineer: The requirements for these degrees are stated on pages 19 and 20.

3. Doctor of Philosophy: The requirements for this degree are stated on page 18.

XII.

Terms and Vacations.

The next academic year begins Thursday, September 10, 1875. The vacations correspond with those of the Academical Department, giving three weeks at Christmas, two weeks in the Spring, and eleven weeks in the Summer.

XIII.

Announcement in Respect to State Students.

The scholarships established in this School in consequence of the bestowal upon it of the Congressional grants are designed to aid young men who are in need of pecuniary assistance in fitting themselves for agricultural and mechanical pursuits of life. All applicants must be citizens of Connecticut. In case there are more applicants than vacancies, candidates will be preferred who have lost a parent in the military or naval service of the United States, and next to these such as are most in need of pecuniary

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assistance: and the appointments will be distributed as far as practicable among the several counties in proportion to their population. The Appointing Board for the current year, consisting of the Board of Visitors of the State and the Secretary of the School, will meet on June 29, 1875, and at about the same time in the year 1876, due notice of which will be given by publication in every county of the State. All applications should be made previous to that time. Blank forms for application will be sent, when requested, by Professor GEORGE J. BRUSH, Secretary of the Appointing Board.

XIV.

Anniversary.

The Anniversary of the School is held on Tuesday of the Commencement week in Yale College, June 29, 1875, when selections from the graduation theses are publicly read. The degrees are publicly conferred by the President and Fellows of Yale College on Commencement Day.

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ELEVENTH

ANNUAL REPORT

OF THE

SHEFFIELD SCIENTIFIC SCHOOL

OF

YALE COLLEGE.

1875-76.

PRINTED BY ORDER OF THE GENERAL ASSEMBLY.

NEW HAVEN:
TUTTLE, MOREHOUSE & TAYLOR, PRINTERS.
1876.

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State Board of Visitors.

CONSTITUTING, WITH THE SECRETARY OF THE SCHOOL, THE BOARD FOR THE APPOINTMENT OF STATE STUDENTS.

GOVERNOR.

His Exc. CHARLES R. INGERSOLL, New Haven.

LIEUTENANT-GOVERNOR.

His Honor GEORGE G. SILL, Hartford.

STATE SENATORS.

Hon. CHARLES M. POND, Hartford.
Hon. MATTHEW BULKLEY, Weston.
Hon. HARVEY B. STEELE, West Winsted.

SECRETARY OF STATE BOARD OF EDUCATION.

Rev. BIRDSEY GRANT NORTHROP, New Haven.

Councillors.

APPOINTED BY THE CORPORATION OF YALE COLLEGE.

Hon. JAMES E. ENGLISH, New Haven.
Hon. MARSHALL JEWELL, Hartford.
Hon. JOSEPH R. HAWLEY, Hartford.
Hon. OLIVER F. WINCHESTER, New Haven.
JOSEPH E. SHEFFIELD, Esq., New Haven.
Prof. JAMES D. DANA, LL.D., New Haven.
HENRY FARNAM, Esq., New Haven.
M. DWIGHT COLLIER, M.A., St. Louis.
Hon. WILLIAM E. DODGE, New York City.

SECRETARY AND TREASURER OF THE SCHOOL.

GEORGE J. BRUSH.

JANITOR OF SHEFFIELD HALL.

ANTON PFEIFER, 55 Lock street.

JANITOR OF NORTH SHEFFIELD HALL.

GEORGE W. STODDARD, 167 Columbus street.

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HARVARD COLLEGE
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REPORT OF THE STATE BOARD OF VISITORS.

To the General Assembly of the State of Connecticut:

The undersigned, in behalf of the State Board of Visitors of the Sheffield Scientific School, would respectfully report that in discharge of their duties they have held the usual meetings during the year; one for the purpose of selecting for the several scholarships open to students, under the laws of the State, those applicants found to be properly qualified; and another at which examination was made of the progress of the School, and especially of its development in connection with the Peabody Museum, the building for which is now completed and prepared to receive much material belonging to the collections of the Scientific School, and to afford commodious rooms and special apartments for instruction in several of its departments.

The report of the Governing Board and Faculty of the Institution, which is herewith submitted, will furnish in detail all needful information respecting the present condition and future promise of the School, and this Board take pleasure in commending the course of instruction now pursued there, and the wisdom, intelligent zeal and personal energy of its corps of instructors, by which the School has been brought to its present leading position among the scientific schools of the country.

The free scholarships which have been so wisely provided by the State, are now largely taken up and with most gratifying results.

In behalf of the Board,

CHARLES R. INGERSOLL,
Chairman.

BIRDSEY G. NORTHROP,
Secretary of the State Board of Education.

NEW HAVEN, May, 1876.

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ANNUAL STATEMENT

OF THE

GOVERNING BOARD.

With the exception of the addition of two new professors to its rps of permanent instructors, the past year has been one of the ast eventful in the history of the School; and in presenting their eventh annual report the Governing Board can do little but re- at the general statements that have already been frequently ade in regard to its condition and prospects. As the change in e time of the meeting of the legislature, in consequence of the nendment of the Constitution to that effect, renders necessary the eparation of an additional report during the current year, it has en deemed advisable to make the present one as brief as possible.

The Peabody Museum.

The Peabody Museum, referred to in the last report, is rapidly lvancing towards completion. When finished, the instruction in ineralogy, Zoology, and Comparative Anatomy, will be given in at building; and laboratories have already been or are being ted up for that purpose. At the beginning of the spring term, e instruction in Determinative Mineralogy was transferred from heffield Hall to the Museum, and that in the other branches men- oned will follow in the course of the next Academic year. A full port of these changes will be found in the next annual report.

Gifts to the Institution.

A gift of one thousand dollars was received for the purpose of ainting Sheffield Hall, and in accordance with the terms of the onation the work was completed during the summer vacation of 875.

Additions to the Corps of Professors.

At the Commencement of 1875, two new professorships were eated, one of Chemistry, the other of Comparative Anatomy.

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To the former Mr. W. G. Mixter was called. Mr. Mixter was graduated from this school in 1867, remained here several years after graduation, pursuing his studies in Chemistry, and was also employed, first as an assistant and subsequently as an instructor in the department of Chemistry. In 1872 he went to Germany, and after spending two years in study in that country, returned to America in 1874, and during the year preceding his appointment gave instruction in Chemistry in the Scientific School. To the chair of Comparative Anatomy Mr. S. I. Smith was elected. He was also graduated from this school in 1867, and since that time has been constantly connected with it as an assistant and subsequently as an instructor.

Instruction in the Use of the Plane Table.

The arrangement by which members of the school could receive instruction in the use of the Plane Table, and in field work, under the operation of the United States Coast Survey, was continued during the past year, though with some modifications. Four topographical parties were constituted and stationed in different sections, one in the Saltonstall Region, one on the New Haven Plain, one east of West Rock Ridge, and one in the Woodbridge Valley. By the plan which had been recommended by Mr. Bache, the Assistant in charge of the region about New Haven, and approved by the Chief of the Coast Survey, each party was made up of a number of paid workers and of such volunteers as might wish to receive instruction. Of the twelve regular employés making up the four parties, the following eight were either students or recent graduates of the Scientific School: H. Andrews, J. P. Bogart, C. V. Pendleton, L. H. Gager, J. G. Bramley, C. McK. Craig, E. B. Chandler, H. D. Bristol. Of the volunteers there were five, all of whom were students in the Scientific School. Their names were as follows: D. R. Alden, W. C. Butler, J. A. Doolittle, E. Gillette, and G. L. Wilson. All of these attached themselves to the party operating in the Woodbridge Valley, that region being the one most easy of access.

Contributions to the Study of the New Haven Region.

To the courtesy of Mr. Bache the Governing Board are under obligations for a report of the operations of the parties, and for the additional contributions to the study of the New Haven Region which follow.

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"It was intended," says Mr. Bache, in his communication to the Governing Board, "to put the parties into the field by April 1st, but the appropriation for the work was not available until July 1st, when the work was begun, ending with the close of November.

"The zone of operations was within a belt of land about four miles in width, stretching from Saltonstall Ridge to Woodbridge Ridge. Just before, and at times during the season, Mr. Andrews, my chief aid, executed the supplementary triangulation, under my general direction. As few of the determinations are represented on the ground by permanent objects, such only are given, with some distances. A few bench-marks in some well-known localities are also given.

"The work of the season consisted of thirty-one triangulation points, one hundred and twenty-four bench-marks for contouring, and twenty-nine square miles of topography. This makes, with what was executed when the survey was merely begun, and then discontinued, four seasons ago, thirty-five square miles towards the topography of the New Haven Region, which includes about one hundred and twenty square miles."

Geographical Positions in the New Haven Region †

Name of Station.	Latitude.			Longitude.		
	°	′	″	°	′	″
East Haven Green Flag-pole,	41	16	29.970	72	52	04.261
Montowese Spire,	41	20	53.414	72	51	45.920
Centreville Spire,	41	22	59.516	72	54	11.635
North Haven Spire,	41	23	10.904	72	51	42.768
City Hall Tower,	41	18	24.475	72	55	30.022

Distances between Triangulation Points within the New Haven Region.

	Meters.
RABBIT ROCK* to Montowese Spire,	1073.6
" Centreville Spire,	6226.6
" North Haven Spire,	5027.4
" East Haven Green Flag-pole,	7488.3
MT. CARMEL* to Montowese Spire,	9430.8
" Centreville Spire,	5358.2
WEST ROCK North* to Montowese Spire,	9171.9
" Centreville Spire,	4957.9
" North Haven Spire,	8426.7
EAST ROCK* to City Hall Tower,	2768.1
WEST ROCK* to City Hall Tower,	4138.6

† The latest Coast Survey *data* for latitude and longitude have been used in the computation of these points.

* The geographical positions of the points thus marked, computed according to the Coast Survey's old *data*, were published in the Scientific School's Report of 1871–72, from the triangulation of Mr. Edward Goodfellow, Assistant U. S. Coast Survey.

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A few Bench Marks in well known Localities.

	Feet.
Southwest corner of second step at the south front entrance to East Haven Church,	21.792
Cross cut on stone door-step of Foxon School-house,	41.013
Top of stone post at the southwest corner of Main and Franklin streets, Westville,	53.458
Top of iron bolt marking the position of "West Rock North," a triangulation point about one and a half miles north of Wintergreen Lake,	559.417

"The plane," continues Mr. Bache, "to which these and all previous elevations are referred, and all future ones will continue to be, is the plane of Mean High Water at Chapel Street Bridge, as determined by the Coast Survey in 1871, during a whole lunation. The height of the lower plane (cut with a saw), on the top of a pile on the north side of the east end of Chapel Street Bridge, is 2.630 feet above the plane of Mean High Water, as there determined. The mean rise and fall of tide there was published in the School's Report of 1871–72, as 6.25 feet, but should have been, according to the tidal record, 6.23 feet. Even this, however, is a small amount in excess of the truth, as has been since ascertained from tidal observations in other parts of the Harbor. The slight excess is owing to local causes at Chapel Street Bridge."

Additions to the Zoological Collections.

A. E. Verrill, Curator; S. F. Clark, Assistant.

The principal additions to the Zoölogical collections during the past year have been made in connection with the explorations of our coast by the United States Commission of Fish and Fisheries, which was located during the summer at Wood's Hole, Mass., on the shore of Vineyard Sound. At this place an excellent zoölogical laboratory—which we hope may be a permanent one—was established, and provided with aquaria and other unusual facilities for the study of marine animals; while the U. S. tug "Bluelight," Commander L. C. Beardslee, was employed, as during several previous summers, for exploring and dredging in the waters of Buzzard's Bay, Vineyard Sound, Nantucket Shoals, etc. The investigation of the marine invertebrates was under the immediate charge of the curator and Professor S. I. Smith, assisted by Mr. S. F. Clark, Mr. C. H. Merriam, Mr. J. K. Thacher, Mr. O. Harger, Mr. Sanderson Smith, Mr. W. H. Dall, and several others. The very extensive collection thus made is now in our possession for study, and for future distribution of the duplicates.

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A part of the marine invertebrates collected by Dr. J. H. Kidder, U. S. N. at Kerguelen Island, and at New Zealand by Dr. E. Kershner, U. S. N., during the Transit of Venus Expedition, were sent here for study, and a report on the Crustacea was prepared by Professor Smith, and others on the Annelids, Echinoderms, and Polyps by the curator. From this collection our museum received a valuable set of duplicates.

Professor S. I. Smith and Mr. S. F. Clark spent a short time at the Smithsonian Institution during the winter vacation. Professor Smith selected a small but valuable series of duplicate Crustacea for our museum, and Mr. Clark brought back the extensive collection of Hydroids made on the coast of Alaska by Mr. W. H. Dall, and has subsequently determined and described the species. A large series of duplicates from this collection will be added to our Museum. Mr. Clark has also described the Hydroids of the California coast in a paper presented to the Connecticut Academy of Science.

The collections of invertebrates from the Gulf of St. Lawrence, collected by Mr. J. F. Whiteaves and sent to Professor Smith and the curator for examination, have been mostly determined and returned, while a series of duplicates from these have also been added to our museum.

From Mr. Henry Hemphill we have received a collection of Crustacea, Echinoderms, Hydroids, Bryozoa, Sponges, etc., from California.

From Dr. Edward Palmer we have also received an important collection of marine invertebrates from southern California.

Professor B. Silliman has presented a collection of fishes, insects, and crustacea, from the Mammoth Cave.

From Professor A. Hyatt, of the Boston Society of Natural History, we have received a valuable set of sponges, identified by him, in connection with his monographic work on the group.

Mr. T. Tomita, Vice-Consul of Japan, presented a specimen of the giant crab of Japan.

Mr. A. G. Wetherby, of Cincinnati, sent a collection of land and fresh water shells.

Several other collections of less importance, which will be enumerated on another occasion, have been received from various sources.

Professor J. D. Dana has presented a valuable lot of Zoölogical books, including a complete series of the Proceedings of the Zoölogical Society of London.

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Additions to the Geological Collections.

O. C. Marsh, Curator; O. Harger, Assistant.

Very important additions to the geological department of the Museum have been made during the year, principally by parties of collectors employed by the curator during the last season in various parts of the West. Several thousand specimens of vertebrate fossils have been thus obtained from the Cretaceous and Tertiary deposits of the Western territories. Many of these are new to science, and some of them of the greatest interest. Among them should be specially mentioned several very perfect specimens of the large and remarkable toothed birds of the genus *Hesperornis*. So complete are these specimens now in the Museum that a study of them promises to determine the characteristics of this group of birds more perfectly than any other fossil birds have been determined, with the possible exception of one or two forms which have very lately become extinct. The Museum has also received much material toward the further elucidation of the characters of the *Dinocerata*, the *Brontotheridæ*, the *Tillodontia* and other hitherto little known groups.

An interesting collection of fossils, mostly vertebrate, has also been received from Mr. G. B. Grinnell and Mr. E. S. Dana who were connected during the last summer with Col. W. M. Ludlow in his trip through the Yellowstone region. These fossils afford evidence of a hitherto unknown Miocene lake basin in the vicinity of Camp Baker, Montana.

The Museum has also received through Prof. Dana several bones of the Reindeer from the Quinnipiac clay pits of North Haven. These bones were carefully collected and presented to the Museum by Capt. S. P. Crafts, the owner of the clay-pits, and are of great interest, as proving the existence of the Reindeer in Southern New England near the close of the glacial period.

Large additions have also been made to the Osteological collection during the year, and many skulls and skeletons, principally of foreign mammals and birds, have been added to the collection. Hon. J. W. Garrett, President of the Baltimore and Ohio Railroad has lately presented to this department the skeleton of the celebrated mare "Esnea," imported from Arabia. A large number of skeletons, mostly of birds, have been received from Mr. G. B. Grinnell during the year. Another interesting acquisition is a series of fifty casts of human and other mammalian brains obtained by the curator from the Royal College of Surgeons, London.

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Public Lectures.

he tenth annual course of lectures to mechanics and others given during the past year in the lecture-room in North ffield Hall. The lectures and their subjects are indicated in annexed programme.

. Mon.,	Feb.	7.	Waves,	C. S. Lyman.
. Thurs.,	"	10.	Yosemite.	Wm. H. Brewer.
. Mon.,	"	14.	The English Language in America,	T. R. Lounsbury.
. Thurs.,	"	17.	Coffee,	D. C. Eaton.
. Mon.,	"	21.	Perspective,	F. R. Honey.
. Thurs.,	"	24.	Turbine Water Wheels,	E. C. Geyelin.
. Mon.,	"	28.	Our Trap Rocks,	G. W. Hawes.
. Thurs.,	March	2.	Sound,	J. Kennedy.
. Mon.,	"	6.	Watt and the Steam Engine,	J. E. Clark.
. Thurs.,	"	9.	The Cost of Labor,	F. A. Walker.
. Mon.,	"	13.	Watt and the Steam Engine,	J. E. Clark.
. Thurs.,	"	16.	Small Arms,	Gen. Wm. B. Franklin.
. Mon.,	"	20.	The Lesser Bodies of the Solar System,	A. W. Wright.
. Thurs.,	"	23.	Animal Instinct,	Wm. H. Brewer.

Anniversary.

he anniversary exercises were held in North Sheffield l, on the evening of Tuesday, June 29, 1875. Nine theses e selected for public reading.

he candidates for degrees, with the subjects of their theses, given in the following schedule. Those marked with an aster were read in the evening.

CANDIDATES FOR DEGREES,

WITH THE SUBJECTS OF THEIR GRADUATION THESES.

CIVIL ENGINEERS. (2)

JEL Hosmer Chittenden, *Guilford.* On the Railroad Bridge at Omaha.

ENZO M. Johnson, *Rochester, Mass.* Design of a Wrought Iron Post Truss Bridge; and a Report upon a Preliminary Survey for the Location of a New Railway Line between Buena Vista and Sound Prairie Stations, Iowa.

DYNAMIC ENGINEERS. (2)

NCIS Urquhart Downing, B.A., Ph.B., *New Haven.* On the American Locomotive.

LIAM Hamden Jenks, Ph.B., *Brookville, Pa.* On the Theory of Turbines.

BACHELORS OF PHILOSOPHY. (49)

RLES Henry Alling (Select), *Birmingham.* On the Railroad System of the United States.

NCELOT Winchester Andrews (Chemistry), *Springfield, Mass.* On the Action of the Alkali Metals on General Compound Ethers.

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*MOSES BRADSTREET BRADFORD (Civil Engineering), *Middletown*. On Tidal Drainage.

JOHN GILBERT BRAMLEY (Civil Engineering), *Bovina, N. Y.* Design for a Stone Bridge.

GEORGE LOOMIS BROWNELL (Civil Engineering), *East Haddam*. On the Iron Truss Bridge over West River.

AMOS AVERY BROWNING (Civil Engineering), *Norwich*. On an Improved Form of the Upright Metallic Arch.

CHARLES STUART BUNCE (Chemistry), *Glastenbury*. On Tungsten.

FRANK TAYLOR CHAMBERS (Dynamic Engineering), *Wilmington, Del.* On the Theory of Iron Ships.

EDWARD BENJAMIN CHANDLER (Civil Engineering), *Woodstock*. On Explosives and their Application in Engineering.

GEORGE RUFUS COOLEY (Civil Engineering), *Hamden*. On the Plane Table.

CHAMBERS MCKIBBIN CRAIG (Civil Engineering), *Alleghany City, Pa.* On the Present System of Sewerage.

*JAMES CUNNINGHAM (Select), *Pittston, Pa.* On the Influence of Geographical Locality on Settlement as Displayed throughout the United States.

CHARLES WILLIAM FENN (Civil Engineering), *Portland, Me.* On the Comparative Compressive Strength of Wrought and Cast Iron.

CHARLES HAMILTON FOX (Select), *Lansingburgh, N. Y.* On Arctic Explorations.

JAMES FREELAND (Civil Engineering), *New York City*. On Ventilation.

LUTHER HENRY GAGER (Civil Engineering), *Coventry*. On Concrete as a Building Material.

LIVINGSTON GIFFORD (Dynamic Engineering), *Jersey City, N. J.* On the Sewing Machine.

WILLIAM CORNELIUS HALL (Civil Engineering), *Buffalo, N. Y.* On the Utilization of Tide Power.

HENRY MORTIMER HASTINGS (Civil Engineering), *Oswego, N. Y.* A Review of the Bridge over the Mattabesett River, Berlin, Ct.

ALFRED PELL HAVEN (Civil Engineering), *New York City*. On the Brooklyn Anchorage of the East River Suspension Bridge.

*CHARLES HILDEBRAND (Dynamic Engineering), *New Haven*. On Screw Propulsion.

THOMAS DOUGLAS HOXSEY (Civil Engineering), *Paterson, N. J.* On the Gunpowder Pile Driver.

WILLIAM READ HOWE (Civil Engineering), *Orange, N. J.* On Tunnels.

*JULIAN KENNEDY (Chemistry), *Struthers, O.* On the Mechanics of Rowing.

EDWARD AUSTIN KENT (Civil Engineering), *Buffalo, N. Y.* On the Heating of Buildings.

GEORGE REINARD KLEEBERGER (Natural History), *Apple River, Ill.* Plantæ Kelloggianæ et Harfordianæ; an Account of Plants collected by Dr. A. Kellogg and Mr. W. G. W. Harford in California, Oregon, etc., during the years 1868 and 1869.

*WELLS CUSHMAN LAKE (Dynamic Engineering), *Lake Forest, Ill.* On Iron in Architectural Construction.

CHARLES PURDY LINDSLEY (Medical), *New Haven*. On Rhus Toxicodendron.

BLANCHARD LYNDE (Select), *Milwaukee, Wis.* On the History of the Usury Laws of England.

CLARENCE FAKE MCMURRAY, *Lansingburgh, N. Y.* On the Gulf Stream.

BURTON MANSFIELD (Select), *New Haven*. On Immigration into the United States.

JOHN CHARLES OLMSTED (Select), *New York City*. On the Moquis Indians.

*EDWARD DAY PAGE (Select), *South Orange, N. J.* On the Effect of the British Poor Laws upon Labor and Wages.

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REDERIC NOAH PEASE (Chemistry), *Ellington.* On the Decompositions of Rocks due to the Action of Organic Acids contained in Lichens.

DWIGHT EDWARD PIERCE (Civil Engineering), *New Haven.* On the Niagara Falls Suspension Bridge.

WILLIAM ARTHUR PRATT (Civil Engineering), *New Haven.* On the Construction and Stability of Dams.

'ILLIAM SHUGARD RIGHTER (Dynamic Engineering), *Newark, N. J.* On Quarrying Machinery.

'ALTER COE ROBERTS (Dynamic Engineering), *New Haven.* On the Principles of Architectural Construction as Embodied in the Peabody Museum.

ICHARD SHARPE (Dynamic Engineering), *Eckley, Pa.* On Machinery for the Manufacture of Wire Rope.

LARENCE HOYT STILSON (Civil Engineering), *Cleveland, O.* On the Railway Passenger Depot, New Haven.

LRED SIDNEY TORRANCE (Select), *Gowanda, N. Y.* On Witchcraft as Represented in the Dramatic Literature of the Elizabethan Period.

FREDERICK MONCRIEFF TURNBULL (Medical), *Hartford.* On the Anatomy of *Nereis Virens.*

LONZO EARL WEMPLE (Select), *Brooklyn, N. Y.* On the Immediate and the Permanent Effects of the British Orders in Council and of the Napoleonic Decrees upon our Commerce and Industry.

'ILLIAM RODMAN WHARTON (Dynamic Engineering), *Germantown, Pa.* On the Transmission of Power by Means of Compressed Air.

LFRED NEWTON WHEELER (Select), *Southford.* On the Postal System of the United States.

ENRY STACY WHIPPLE (Civil Engineering), *Birmingham.* On the Fourth Avenue Improvement, New York City.

DWARD LUTHER WHITE (Civil Engineering), *Waterbury.* On the Gilbert Elevated Railway.

EORGE HORACE WILCOX (Dynamic Engineering), *West Meriden.* On the Meriden Woolen Mill.

ENJIRO YAMAGAWA (Civil Engineering), *Japan.* An Investigation of Curves Formed by the Trigonometric Functions.

PRIZES.

CLASS OF 1875.

r excellence in German, the prize awarded to CHARLES W. FENN, *Portland, Me.*

r excellence in Civil Engineering, the prize awarded to WILLIAM A. PRATT, *New Haven.*

CLASS OF 1876.

r excellence in the Mathematics of Junior Year, the prize divided between PORTER D. FORD, *Washington*, and HIRAM A. MILLER, *New Haven.*

r excellence in Chemistry, the prize divided between FREDERICK P. DEWEY, *West Haven*, and FREDERICK P. MILES, *Salisbury.*

r excellence in Mineralogy, the prize awarded to FREDERICK P. DEWEY, *West Haven.*

CLASS OF 1877.

r excellence in all the Studies of Freshman Year, the prize awarded to WALLACE B. FENN, *New Haven*, with honorable mention of JOSEPH G. CALHOUN, *Hartford.*

r excellence in German, the prize divided between JOSEPH P. IDDINGS, *Orange, N. J.*, and WILLIAM T. SEDGWICK, *Farmington.*

r excellence in Mathematics, the prize divided between JOHN E. BUDDINGTON, *Huntington*, and WALLACE B. FENN, *New Haven.*

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For excellence in Physics, the prize awarded to JOSEPH G. CALHOUN, *Hartford.*

For excellence in Mechanical Drawing, the prize awarded to JOSEPH P. IDDINGS, *South Orange, N. J.*

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For the best Entrance Examination, the prize divided between GEORGE W. MASON, *Orange, N. J.*, and EBEN J. WARD, *Chicago, Ill.*, with honorable mention of CHARLES S. CHURCHILL, *New Haven.*

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)F STUDIES,

) GUE,

)ar 1875--76.

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CALENDAR.

1875.		
16 Sept.	Thursday,	First Term begins.
23 Dec.	Thursday,	First Term ends.
		Winter Vacation of two weeks.
1876.		
6 Jan.	Thursday,	Second Term begins.
6 April,	Thursday,	Second Term ends.
		Spring Vacation of two weeks.
20 April,	Thursday,	Third Term begins.
27 June,	Tuesday,	Meeting of Appointing Board.
27 June,	Tuesday,	Anniversary.
29 June,	Thursday,	Commencement.
30 June,	Friday,	Examination for Admission.
1 July,	Saturday,	
		Summer Vacation of eleven weeks.
12, 13 Sept.	Tues., Wedn.,	Examination for Admission.
14 Sept.	Thursday,	First Term begins.
21 Dec.	Thursday,	First Term ends.

ABBREVIATIONS.

S. H.	Sheffield Hall.
N. S. H.	North Sheffield Hall.
TR.	Treasury Building.
D.	Durfee College.
F.	Farnam College.
D. H.	Divinity Hall.
W. D. H.	West Divinity Hall.

In the buildings belonging to the Sheffield Scientific School, the rooms n
bered from 1 to 21 are in Sheffield Hall: from 26 to 58 in North Sheffield Ha

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GRADUATES 30.

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SENIOR CLASS.

ıt Alden,	*Westville*,	126 High st.
ırren Allen,	*Jersey City, N. J.*	63 W. D. H.
ırcelon Andrews,	*Norwich*,	22 Trumbull st.
ɔen Bacon,	*Middletown*,	525 Chapel st.
ıring Brace,	*Hastings, N. Y.*	90 High st.
'ood Brown,	*West Haven*,	West Haven.
.cCulloh Brown,	*Brookline, Mass.*	143 York st.
owning,	*Norwich*,	90 High st.
ɔveland Butler,	*New Haven*,	113 Olive st.
ɔph Caswell,	*Norwich*,	125 High st.
'y Chapman,	*New York City*,	46 Elm st.
lliams Clark,	*Hartford*,	62 W. D. H.
at Cunningham,	*Poughkeepsie, N. Y.*	62 W. D. H.
Perkins Dewey,	*West Haven*,	8 Lock st.
rnwall Dunham,	*Southington*,	66 Bradley st.
man Fitch,	*New Haven*,	46 High st.
ırbes,	*San Francisco, Cal.*	144 Orange st.
vingston Ford,	*Buffalo, N. Y.*	48 College st.
ight Ford,	*Washington*,	125 Dwight st.
ısper Francke,	*New York City*,	68 W. D. H.
ıkson Gibson,	*New Haven*,	44 Edwards st.
illette,	*New Haven*,	15 Columbus st.
Hammond,	*San Francisco, Cal.*	36 Elm st.
'rence Houghteling,	*Chicago, Ill.*	36 Elm st.
unt,	*New Orleans, La.*	36 Elm st.
ine Johnson,	*Brooklyn, N. Y.*	94 Grove st.
'ksbury Law,	*Tarrytown, N. Y.*	94 Grove st.
ɔward Linsley,	*West Meriden*,	36 Elm st.
cis Luby,	*New Haven*,	21 Nash st.
ton Macgregor,	*New York City*,	161 Temple st.
.ouse,	*New Haven*,	49 Meadow st.
eyer,	*New York City*,	35 College st.
Plumb Miles,	*Salisbury*,	64 W. D. H.
ɔn Miller,	*New Haven*,	133 College st.
ayo Newhall,	*San Francisco, Cal.*	36 Elm st.
rt Paddock,	*Cheshire*,	88 Wall st.
ɔach Palmer,	*Bridgeport*,	61 W. D. H.
ırned Ryerson,	*Chicago, Ill.*	36 Elm st.
ıbcock Sawyer,	*Buffalo, N. Y.*	191 Temple st.
ıvid Seeberger,	*Chicago, Ill.*	133 College st.

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Frederick Wood,	*Norwalk,*	191 Temple st.
Thomas Yeatman,	*New Haven,*	36 Elm st.

SENIORS, 52.

JUNIOR CLASS.

William Whittlesey Abbott,	*Yarmouth, Me.*	29 Prospect st.
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George Henry Bartlett,	*North Guilford,*	157 Church st.
Charles Coffing Beach,	*Hartford,*	159 Temple st.
Morris Burke Belknap,	*Louisville, Ky.*	14 Lock st.
Bernard Berens,	*Philadelphia, Pa.*	42 Grove st.
Arthur Lewis Betts,	*Norwalk,*	Westville.
Frank Lewis Bidwell,	*Kansas City, Mo.*	64 W. D. H.
John Edwards Buddington,	*Huntington,*	Huntington.
Lucien Lowber Burrows,	*Decatur, Ill.*	120 High st.
Herman Beardsley Butler,	*New York City,*	36 Elm st.
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Alfred Chapman,	*Bethel,*	99 Wall st.
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William Edgar Gard,	*New York City,*	116 W. D. H.
Charles Cartledge Godfrey,	*Southport,*	41 College st.
John Elisha Morpeth Hall,	*Brooklyn, N. Y.*	46 York sq. pl.
William Torrence Handy,	*Cincinnati, O.*	159 George st.
William Stanley Hine,	*Bridgeport,*	Bridgeport.
Walter Holcomb,	*New Hartford,*	73 Trumbull st.
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Horace Cobb Howard,	*Townsend, Vt.*	8 Lock st.
Joseph Paxon Iddings,	*Orange, N. J.*	119 W. D. H.

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›s Maples Jarvis,	*Binghamton, N. Y.*	65 W. D. H.
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Thien Foh Laisun,	*Shanghai, China,*	226 Church st.
Cooper Lawrence,	*New York City,*	488 Chapel st.
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›s James Luck,	*Rouse's Point, N. Y.*	44 York sq. pl.
r John Martin,	*Orange, N. J.*	70 W. D. H.
›s Knox Mixter,	*Rock Island, Ill.*	116 W. D. H.
›s Arthur Montjoy,	*Lambayeque, Peru,*	15 Home pl.
Blair Murray,	*Norwich,*	125 Dwight st.
›l Lewis Penfield,	*Catskill, N. Y.*	58 Trumbull st.
›d Nourse Platt,	*Elmira, N. Y.*	48 College st.
niel Chapin Ray,	*West Haven,*	271 Chapel st.
›s Rawlinson Read,	*Hartford,*	90 High st.
Tracey Richards,	*Stratford,*	61 W. D. H.
› Waterman Robinson,	*Fair Haven,*	255 Ferry st.
›s Weaver Rogers,	*Brooklyn, N. Y.*	8 Lock st.
›s Fitch Rowland,	*Greenpoint, N. Y.*	92 Chapel st.
›t Rushmore,	*Mamaroneck, N. Y.*	161 Temple st.
Alvin Scott,	*Naugatuck,*	1 Whalley av.
m Thompson Sedgwick,	*Farmington,*	4 Library st.
›s Dwight Smith,	*Plantsville,*	133 College st.
e Smith,	*New Haven,*	164 Elm st.
r Snowdon Smith,	*Cincinnati, O.*	458 Chapel st.
Ling Taylor,	*New York City,*	58 W. D. H.
r John Tenny,	*New Haven,*	126 Crown st.
Mason Thomas,	*Wickford, R. I.*	193 Temple st.
m Gilman Thompson,	*New York City,*	251 Church st.
Abeel Weekes,	*New York City,*	161 Temple st.
e Lemuel Wells,	*New Britain,*	66 Bradley st.
Harold Wickersham,	*Lancaster, Pa.*	165 Temple st.
Willard Williams,	*Glastenbury,*	136 Crown st.
Daniel Wilson,	*Newburg, N. Y.*	42 Grove st.
e Leverett Wilson,	*West Killingly,*	8 Lock st.
Young,	*Homesdale, Pa.*	251 Church st.

JUNIORS, 63.

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FRESHMAN CLASS.

Frederick Innis Allen,	*Auburn, N. Y.*	35 High st.
William Day Allen,	*Hartford,*	84 Wall st.
Seymour Landon Alvord,	*West Winsted,*	193 Temple st.
John Pomeroy Bartlett,	*New Britain,*	88 Wall st.
John Luis Blackmore,	*City of Mexico, Mexico,*	40 Park st.
Edward Everett Brewster,	*West Cornwall,*	79 Chapel st.
Thomas Deloss Bristol,	*Harwinton,*	Fair Haven.
Fayette Williams Brown,	*Yonkers, N. Y.*	133 College st.
William Tyler Browne,	*Lisbon,*	175 George st.
Charles William Canfield,	*Hartford,*	81 Wall st.
Robert Williams Chapin,	*Springfield, Mass.*	162 York st.
William Grover Chapin,	*Somers,*	44 York sq.
Charles Samuel Churchill,	*New Haven,*	257 Franklin st.
Walter Linsley Cowles,	*Wallingford,*	432 Chapel st.
William Sidney Downs,	*Birmingham,*	Birmingham.
Charles Augustus Dwinelle,	*New York City,*	18 Grove st.
Edward Caldwell Earle,	*New Haven,*	214 Orchard st.
Levi Abraham Eliel,	*Chicago, Ill.*	523 Chapel st.
Augustus James Emery,	*Bangor, Me.*	547 Howard av.
Granger Farwell,	*Chicago, Ill.*	41 College st.
Oswin Hart Doolittle Fowler,	*North Haven,*	432 Chapel st.
Allan Murray Gale,	*New Haven,*	87 Trumbull st.
John Currier Gallagher,	*New Haven,*	21 Olive st.
Jonathan Godfrey.	*Southport,*	41 College st.
William Augustus Goodman,	*Cincinnati, O.*	464 Chapel st.
Cadmus Zaccheus Gordon,	*Brookville, Pa.*	8 Lock st.
Rodney Granger,	*Chicago, Ill.*	41 College st.
Leonard Vassall Greene,	*Norwich,*	134 College st.
Ralph Augustus Harman,	*Cleveland, O.*	114 College st.
Gerald Waldo Hart,	*New Britain,*	124 High st.
Walter Tillman Hart,	*New Haven,*	44 High st.
George Stewart Hegeman,	*Brooklyn, N. Y.*	156 York st.
Frank Eugene Hemingway,	*New Haven,*	122 Park st.
Charles Betts Hillhouse,	*New Haven,*	3 Hillhouse av.
Charles DeVilliers Hoard,	*Chicago, Ill.*	416 Chapel st.
Robert Samuel Hulbert,	*West Winsted,*	193 Temple st.
Thomas Mastin Jacks,	*Helena, Ark.*	8 Elm st.
Fred Beckwith Jillson,	*Whitehall, N. Y.*	83 Olive st.
Willard Drake Johnson,	*Washington, D. C.*	23 Prospect st.
John Philbrick Laflin,	*Chicago, Ill.*	114 High st.
Effingham Lawrence,	*New Orleans, La,*	464 Chapel st.
Edward Charless LeBourgeois,	*St. James Parish, La.*	464 Chapel st.
Charles Richard Lee,	*Kenosha, Wisc.*	31 E. D. H.
Arthur Lyman,	*Leominster, Mass.*	116 College st.
Elbert Baldwin Mann,	*Rochester, N. Y.*	15 Home pl.

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Webb Mason,	*Orange, N. J.*	119 W. D. H.
eterson Mitchell,	*Cincinnati, O.*	84 Wall st.
hilip Montjoy,	*Lambayeque, Peru,*	258 Orange st.
James Perry Moore,	*New Britain,*	79 William st.
ırner Moorhead,	*Pittsburgh, Pa.*	459 Chapel st.
erce Morrison,	*Santa Clara, Cal.*	61 Grove st.
acy Watkins Palmer,	*Chicago, Ill.*	464 Chapel st.
renville Parkin,	*New York City,*	84 Wall st.
Vilson Patrick,	*Omaha, Nebr.*	531 Chapel st.
enry Pierce,	*Santa Clara, Cal.*	61 Grove st.
Ienry Potts,	*Pittstown, N. J.*	133 College st.
Eckhardt Raht,	*Cleveland, Tenn.*	8 Lock st.
Townsend Reed,	*Albany, N. Y.*	15 Home pl.
Theodore Richmond,	*Johnsonville, N. Y.*	83 Olive st.
Kilbourn Roberts,	*New Haven,*	8 Brown st.
oorbach,	*New York City,*	12 Home pl.
Hubbard Russell,	*New Haven,*	11 Wooster pl.
enry Skeel,	*Newburgh, N. Y.*	23 Prospect st.
Herndon Smith,	*Brooklyn, N. Y.*	133 College st.
s Henry Spencer,	*Suffield,*	69 Bradley st.
Annin Vliet,	*Cleveland, O.*	133 College st.
Augustus Wall,	*Providence R. I.*	162 York st.
inings Ward,	*Chicago, Ill.*	523 Chapel st.
Vatson,	*Northampton, Mass.*	90 Grove st.
nelon Seely White,	*New Haven,*	104 York st.
Benjamin Wilson,	*Elizabeth, N. J.*	Milford.
Dana Winslow,	*Washington, D. C.*	165 Temple st.
Hopkins Young,	*Poughkeepsie, N. Y.*	161 Temple st.

FRESHMEN, 73.

SPECIAL STUDENTS NOT CANDIDATE FOR A DEGREE.

aveley Andrews,	*Sussex, England,*	37 Clark st.
Batcheller,	*Boston, Mass.*	30 Trumbull st.
Attwater Bostwick,	*New Haven,*	162 Olive st.
hamberlain Bragg,	*Milford, Mass.*	27 Prospect st.
ldwell,	*Carthage, O.*	58 W. D. H.
Tessenden Clark,	*Geneva, Ill.*	58 N. S. H.
Hart Merriam,	*Locust Grove, N. Y.*	42 Whitney av.
ierce Morgan,	*Woodbridge,*	Woodbridge.
dward Nichols,	*Yonkers, N. Y.*	165 Temple st.
eland Upham,	*Yonkers, N. Y.*	191 Temple st.
Alfred Vernon,	*Brooklyn, N. Y.*	205 Orange st.
Beecher Wilson,	*Geneva, Ill.*	27 Prospect st.

SPECIAL STUDENTS, 12.

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SUMMARY.

Graduates,	30
Seniors,	52
Juniors,	63
Freshmen,	73
Special Students,	12
Total,	230

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SHEFFIELD SCIENTIFIC SCHOOL.

I.

Objects.

'HE SHEFFIELD SCIENTIFIC SCHOOL is devoted to instruction researches in the mathematical, physical, and natural sciences, h reference to the promotion and diffusion of science, and also he preparation of young men for such pursuits as require ecial proficiency in these departments of learning. It is one of Departments of Yale College, like the law, medical, theologi- and art schools, having its separate funds, buildings, teachers, regulations, but governed by the Corporation of Yale College, ch appoints the professors and confers the degrees. It is, in t, analogous to the academic department or classical college, , in part, to the professional schools.

'he instruction is intended for two classes of students:—

Graduates of this or of other Colleges, and other persons lified for advanced or special scientific study.

[. Undergraduates who desire a training chiefly mathematical scientific, in less part linguistic and literary, for higher scien- studies, or for various other occupations to which such ning is suited.

II.

History and Organization.

he School was commenced in 1847. In 1860, a convenient ding and a considerable endowment were given by Joseph E. ffield, Esq., of New Haven, whose name, at the repeated request he Corporation of Yale College, was afterward attached to foundation. Mr. Sheffield has since frequently and munifi- ly increased his original gifts.

1 1864, by an act of the Connecticut Legislature, the national it for the promotion of scientific education (under the con- sional enactment of July, 1862) was given to this department Yale College, which thus became "the College of Agriculture

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and the Mechanic Arts for Connecticut." Since that time, and especially since the autumn of 1869, numerous liberal gifts have been received from the citizens of New Haven, and from other gentlemen in Connecticut, New York, and St. Louis, for the endowment of the School, and the increase of its collections.

The action of the State led to the designation by law of a State Board of Visitors, consisting of the Governor, Lieutenant-Governor, three senior Senators, and the Secretary of the State Board of Education; and this Board, with the Secretary of the Scientific School, is also the Board for the appointment of students to hold the State scholarships.

At the request of the Governing Board, the Corporation of Yale College has also appointed a board of Councillors for the School, consisting of a number of gentlemen who have taken a deep interest in its welfare.

The Governing Board consists of the President of Yale College and the Professors who are permanently attached to the School. There are several other instructors associated with them, a part of whom are connected with other departments of the College.

III.

Building and Apparatus.

The two buildings in which the work of instruction in the Scientific School is carried on are called Sheffield Hall and North Sheffield Hall. These contain a large number of recitation and lecture rooms, a hall for public assemblies and lectures, chemical and metallurgical laboratories, a photographical room, an astronomical observatory, museums, a library and reading room, besides studies for some of the professors, where their private technical libraries are kept.

The following is a summary statement of the collections belonging to the school:—

1. Laboratories and Apparatus in Chemistry, Metallurgy, Physics, Photography, and Zoölogy.
2. Metallurgical Museum of Ores, Furnace Products, etc.
3. Agricultural Museum of Soils, Fertilizers, useful and injurious insects, etc.
4. Collections in Zoölogy.
5. Astronomical Observatory, with an equatorial telescope by Clark and Sons of Cambridge, a meridian circle, etc.
6. A Collection of Mechanical Apparatus, constituting the "Collier Cabinet."

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ls in Architecture, Geometrical Drawing, Civil Engineering, Topographica
ineering, and Mechanics; diagrams adapted to public lectures; instru
its for field practice.
and Charts, topographical, hydrographical, geological, etc.
eralogical cabinet of Professor Brush, the herbarium of Professor Brewe
collection of native birds of Professor Whitney, and the astronomica
ruments of Professor Lyman, are deposited in the building. Professo
on's herbarium, near at hand, is freely accessible.

ents are also admitted, under varying conditions, to th
e and Society libraries, the College Reading Room, th
t of Minerals and Fossils, the School of the Fine Arts, an
mnasium.

IV.

The Library.

special technical library of the Scientific School consists o
five thousand volumes. Included in this is the "Hillhous
natical Library" of twenty-four hundred volumes, collecte
a long series of years by Dr. William Hillhouse, and si
go purchased and presented to the Institution by Mr. Shef
A Catalogue of this collection forms a supplement to th
l Report of the Governing Board for 1870.
following scientific journals are received regularly at th
y, and are accessible to all for consultation.

AMERICAN.

ournal of the Franklin Institute.
ngineering and Mining Journal.
ientific American.
lining and Scientific Press.
an Nostrand's Eclectic Engineering Magazine.
ailroad Gazette.
ulletin of the National Association of Wool Manufacturers.
merican Chemist.
merican Journal of Science.

ENGLISH.

gricultural Gazette, The.
nnals and Magazine of Natural History.
uilder, The.
conomist, The.
ngineer, The.
ngineering.
armer's Magazine.
arden, The.
ardiner's Chronicle, The.
revillea.

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Iron.
Journal of the Anthropological Institute.
——— of the Chemical Society.
——— Quarterly, of Microscopical Science.
——— Quarterly, of Pure and Applied Mathematics.
——— Quarterly, of Science.
Magazine, The Botanical.
Mining Journal, The.
Monthly Notices of the Royal Astronomical Society.
Nature.
News, The Chemical, and Journal of Physical Science.
Philosophical Magazine, The London, Edinburgh, and Dublin.

FRENCH.

Annales de Chimie et de Physique.
——— Nouvelles de la Construction.
——— des Ponts et des Chaussées.
Archives de Zoölogie Experimentale et Generale.
Bulletin de la Société de Géographie.
——— de Société Chimique.
Connaisance des Temps.
Journal d'Agriculture Pratique.
——— de Zoologie.
Mondes, Les.
Revue Scientifique.
——— Universelle des Mines.
Technologiste, Le.

GERMAN.

Annalen der Landwirthschaft.
——— der Physik und Chemie.
Archiv für Anthropologie.
Berichte der Deutschen Chemischen Gesellschaft.
Centralblatt Chemisches.
——— Polytechnisches.
Civil-Ingenieur, Der.
Hedwigia.
Jahrbuch, Berliner Astronomisches.
——— über die gesammten Fortschritte der Mathematik.
Journal für reine und angewandte Mathematik.
Landwirthschaftliche Jahrbücher.
Milch-Zeitung.
Nachrichten, Astronomische.
Polytechnisches Journal, Dingler's.
Repertorium für Experimental-Physik, etc.
Zeitschrift für Biologie.
——— für Analytische Chemie.
——— für Math. und Naturw. Unterricht.
——— für Wissenschaftliche Zoologie.
Zeitung, Berg-und Hüttenmännische.
———Botanische.

Niederländisches Archiv für Zoologie.

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Numerous scientific journals, not included in this list, can be found in the private libraries of various professors, which are deposited in the building, and are accessible for consultation; and in the College library there are a much larger number of others, especially of the proceedings of foreign academies and scientific societies.

V.

Instruction for Graduate and Special Students.

Persons who have gone through undergraduate courses of study, here or elsewhere, may avail themselves of the facilities of the School for more special professional training in the physical sciences and their applications, gaining in one, two, or three years the degree of BACHELOR OF PHILOSOPHY, or, in two additional years of Engineering study, that of CIVIL ENGINEER, or of DYNAMICAL ENGINEER.

Or, engaging in studies of a less exclusively technical character, they may become candidates for the degree of DOCTOR OF PHILOSOPHY. The instruction in such cases will be adapted to the particular needs and capacities of each student, and may be combined with that given by the graduate instructors in other departments of the University. This degree is conferred upon those who, having already taken a Bachelor's degree, engage as students in the Department of Philosophy and the Arts for not less than two years in assiduous and successful study. It is not given upon examination to those whose studies are pursued elsewhere. The requirements for it will in some cases exact of the student more than two years of post-graduate labor; so, especially, wherever the course of undergraduate study has been, as in the Scientific School, of less than four years. The candidate must pass a satisfactory final examination, and present a thesis giving evidence of high attainment in the branches of knowledge to which he has attended. A good knowledge of Latin, German and French will be required in all cases, unless, for some exceptional reason, the candidate be excused by the Faculty. The graduating fee is ten dollars.

Subjects likely to receive special attention are suggested as follows:—

Professor NORTON will instruct in applied mechanics and in spherical astronomy.

Professor LYMAN, in the use of meridional and other astronomical instruments, and in astronomical spectroscopy.

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Professor TROWBRIDGE, in the principles of thermodynam
and utilization of heat as a source of power.

Professor BRUSH, in the analysis and determination of min
species, and in descriptive mineralogy.

Professor JOHNSON, in theoretical, analytical, and agricult
chemistry.

Professor BREWER, in agriculture and forest culture, in the
of the microscope, and in physical geography.

Professor CLARK, in definite integrals, differential equati
analytical mechanics, the theory of numerical approximations,
the method of least squares.

Professor EATON, in structural and systematic botany, includ
the North American flora and the description of genera and spec

Professor MARSH, in palæontology and comparative osteolo

Professor WALKER, in public finance and in the statistics of
dustry.

Professor ALLEN, in analytical chemistry, and in metallurgy.

Professor VERRILL, and Mr. S. I. SMITH, in zoölogy and geolo

The same courses of study are open, for a longer or shorter ti
to graduate students who do not desire to become candidates f
degree.

Students who have taken the degree of Bachelor of Philosop
may obtain the degree of CIVIL or of DYNAMIC ENGINEER at
end of two academical years, by pursuing the following hig
course of study and professional training.

The course of study for the degree of CIVIL ENGINEER will c
prise—

1. Higher Calculus. Higher Geometry. Theory of Numerical Operation
2. Analytical Mechanics. Mechanics applied to Engineering.
3. A Course of Construction and Design. Projects.
4. Practical Astronomy, with use of instruments, computations, etc.

This course will occupy three academical terms.

To secure the requisite amount of professional knowledge
practice, the candidate will be required to furnish a comprehens
report of the results of an examination into the existing condit
of some special line of constructive art; or to present proper
dence that he has had actual charge in the field, for several mont
of construction or surveying parties, or held some responsible p
ion deemed equivalent to this.

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An elaborate design must also be submitted of some projected work of construction, based upon exact data obtained from careful surveys made by the candidate, and comprising all the requisite calculations, and the necessary detailed drawings, and accompanied by full specifications of the work to be done, and the requirements to be met by the contractor.

The fee for this degree is five dollars.

The course of study for the degree of DYNAMICAL ENGINEER will comprise

1. Higher Calculus, General Theory of equations and of Numerical Operations.
2. General Principles of Dynamics (Analytical Mechanics.) Including special application of these principles to Dynamical problems.
3. Construction of Machines. Designs.
4. Preparation of theses on special subjects in Dynamic Engineering.

During the second year candidates will be permitted to employ such a portion of their time as may be deemed advisable or necessary in the examination of engineering works and manufacturing establishments, and may also have the privilege of entering upon professional practice, provided it is done with the knowledge and consent of the Professor of Dynamic Engineering, and under such circumstances as shall appear to him to be favorable to professional progress.

An elaborate thesis on some professional subject, with an original design, or project, accompanied by proper working drawings, will be required at the end of the second year.

The fee for this degree is five dollars.

SPECIAL STUDENTS.—For the benefit of those who, being fully qualified, desire to pursue particular studies without reference to the obtaining of a degree, special or irregular students are received in most of the departments of the School; not, however, in the Select Course or in the Freshman Class.

It should be distinctly understood that these opportunities are not offered to persons who are incompetent to go on with regular courses, but are designed to aid those who, having received a sufficient preliminary education elsewhere, desire to increase their proficiency in special branches.

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VI.

Requirements for Admission.

TERMS OF ADMISSION.—Candidates must be not less t
years of age, and must bring satisfactory testimonia
character from their former instructors or other resp
sons.

For admission to the Freshman Class the student m
thorough examination in the following subjects:

English Grammar—including spelling and composition.
History of the United States.
Geography.
Latin—Six books of Cæsar's commentaries or their equivalent, a
ercises in prose composition.

Arithmetic—including the Metric System.
Algebra—Davies' Bourdon, or Loomis's Treatise, as far as the gen
equations; or an equivalent.
Geometry—Chauvenet's Geometry; or an equivalent.
Plane Trigonometry—an equivalent to Loomis's Plane Trigonom
Plane and Analytical Trigonometry of Davies' Legendre.
(In the examinations of 1877, Snowball and Lund's Course o
Natural Philosophy* will be required.)

The examinations for admission take place at Nort
Hall, on Friday and Saturday, June 30, July 1; and
and Wednesday, September, 12, 13, 1876. Opportun
vate examination may, in exceptional cases, be giv
times.

Candidates for advanced standing in the undergradu
are examined, in addition to the preparatory studies,
ready pursued by the class they propose to enter. No
admitted as a candidate for a degree later than at the
of the Senior year.

For the guidance of students purposing to enter this
the following information is furnished in regard to
ments in certain studies; not necessarily because t
mentioned are of any more importance in themselves, l
experience has shown that they are the subjects in
didates are generally apt to be to a greater or less exte

* Published by Macmillan & Co., London and New Yor

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Arithmetic.—The examination in this study will embrace the leading topics taught in the high schools of the country. It will extend to the rationale of arithmetical processes as well as to the processes themselves; and candidates should, therefore, have carefully reviewed the subject, after having attained sufficient maturity to comprehend it.

Algebra.—The following subjects will receive special attention in the examination in this branch:

The fundamental operations upon both entire and fractional expressions, including factoring; the solution of equations of the first and second degree; the reduction of inequalities; the theory of fractional and negative exponents, and the calculus of radicals; the application of the binomial formula, whatever be the exponent; the method of indeterminate co-efficients; and the theory and use of logarithms. There is far too often a general want of thoroughness in the preparation of candidates in this fundamental branch of mathematical analysis.

Geometry.—In this subject the candidate should have in his preparation a sufficient number of not too difficult exercises in geometrical invention, such as can be chosen from the works of Loomis, Chauvenet, Tappan, and Olney, and further found in abundance in various English and other foreign collections. Particular attention should also be paid to exercises in the elementary formulæ of mensuration.

Trigonometry.—In Trigonometry it is absolutely requisite that the candidate make himself thoroughly familiar with the deduction of the formulæ, with the use of the trigonometrical tables, and the solution of plane triangles. He should besides be exercised as far as practicable in simple trigonometrical transformations. Todhunter's "Trigonometry for Beginners" will furnish abundant material for this class of exercises. In his Trigonometrical calculations, as in all others, he should study the art of neat and orderly arrangement, as an important means to a valuable end. If the use of Logarithms is postponed till this subject is taken up (which is by no means advisable), it should embrace all forms of calculation occurring in ordinary practice, as well as those appearing in the solution of triangles; since any one of the former is liable at any time to appear in the work given in the examinations.

Latin.—In order to assure the attainment of the required proficiency in this study, the student should have such continued training in parsing as shall make him thoroughly familiar with

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declensions and conjugations, and accurate and ready in the application of the rules of syntax. As an additional guarantee of the proper mastery of these grammatical elements the requirement has been adopted of "simple exercises in prose composition." By this is meant, merely, such a course of elementary exercises in translating, orally and, in writing, from English into Latin as, in connection with the systematic parsing just mentioned, shall necessitate a familiarity with grammatical forms and the leading principles of syntax, and thus render the reading of the six books of Cæsar (or their equivalent) more thorough and fruitful. Since this course of elementary exercises in translation is designed as a preparation for reading, and not as a sequel to it, it should be invariably begun at the earliest stage of the study of Latin. To avoid any misapprehension of the nature or the extent of the requirement the following works are specifically named, among which the candidate for examination may make his own election. These are Harkness' "Introduction to Latin Composition," 112 pages; Leighton's "Latin Lessons," 91 pages; Smith's "Principia Latina," Part I.; or McClintock's "First Latin Book," 83 lessons (193 pp.). Any equivalent of these may be offered from the many useful books of a similar character. A knowledge of Prosody is not required.

VII.

Instruction for Undergraduate Students.

COURSES OF INSTRUCTION, occupying three years, are arranged to suit the requirements of various classes of students. The first year's work is the same for all; during the last two years the instruction is chiefly arranged in special courses.

The special courses most distinctly marked out are the following:—

(a.) In Chemistry;
(b.) In Civil Engineering;
(c.) In Dynamic (or Mechanical) Engineering;
(d.) In Agriculture;
(e.) In Natural History;
(f) In studies preparatory to Medical Studies;
(g.) In studies preparatory to Mining and Metallurgy;
(h.) In Select studies preparatory to other higher studies.

The arrangement of the studies is indicated in the annexed scheme.

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FRESHMAN YEAR.—INTRODUCTORY TO ALL THE COURSES.

FIRST TERM. — *German*, — Whitney's Grammar and Reader. *English*, — Hadley's Brief History of the English Language; Exercises in Composition. *Mathematics*,—Plane Analytical Geometry. *Physics*,—Atkinson's Ganot, with experimental lectures. *Chemistry*,—Eliot and Storer's Manual: Laboratory practice. *Elementary Drawing*,—Practical Lessons in the Art School.

SECOND TERM.—*Language, Physics, Chemistry, and Drawing*.—As stated above. *Mathematics*,—Elements of the Theory of Numerical Approximations; Solution of Higher Numerical Equations; Methods of Interpolation. *Physical Geography*,—Lectures.

THIRD TERM.—*German and Physics*,—As stated above. *Mathematics*,—Analytical Geometry in Space; Spherical Trigonometry. *Botany*,—Gray's Lessons. Lectures. *Polit. Economy*,—Elementary Lectures. *Drawing*.—Orthographic Projection.

For the Junior and Senior years the students select for themselves one of the following courses :—

(a.) IN CHEMISTRY.

JUNIOR YEAR.

FIRST TERM.—*Theoretical and Organic Chemistry*,—Lectures. *Qualitative Analysis*,—Fresenius. *Laboratory Practice. Blowpipe Analysis. German. French.*

SECOND TERM.—*Laboratory Practice*,—Qualitative Analysis, continued. Quantitative Analysis, begun. *Mineralogy*,—Blowpipe Analysis and Determination of Species. *Zoology*,—Lectures. *German. French.*

THIRD TERM.—*Laboratory Practice*,—Quantitative Analysis, continued. *Mineralogy*,—Lectures. *Zoology*,—Lectures and Excursions. *German. French.*

SENIOR YEAR.

FIRST TERM.—*Laboratory Practice*,—Volumetric and Organic Analysis. *Geology*,—Dana's. *Zoology*,—Lectures. Excursions. *French.*

SECOND TERM.—*Laboratory Practice.* Mineral Analysis and Assaying. *Agricultural Chemistry*,—Recitations and Lectures (optional). *Geology*,—Dana's. *Metallurgy* (optional). *French. Zoology*,—Lectures.

THIRD TERM.—*Laboratory Practice.* Preparation of Thesis. *Agricultural Chemistry*,—Lectures (optional). *Geology*,—Dana's. *Metallurgy* (optional). *Mineralogy* (optional). *French. Zoology*,—Lectures.

(b.) IN CIVIL ENGINEERING.

JUNIOR YEAR.

FIRST TERM.—*Mathematics*,—Differential and Integral Calculus. Descriptive Geometry. *Surveying*,—Field Operations. *Drawing*,—Binns' Orthographic Projections. *German. French.*

SECOND TERM.—*Mathematics*,—Integral Calculus. Rational Mechanics. *Drawing*,—Projection of Shadows and Perspective. *German. French.*

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Quantities of heat. Latent heats of fusion and evaporation. *Combustion*,—Quantities of air required, nature of products, heat evolved. *Fuel*,—Kinds and quantities transfer of heat. *Description of Steam Generators*,—Principles of construction of steam generators. *Geology*. *French*.

THIRD TERM.—*Prime Movers in General*,—Animal Mechanics, water powers, heat engines, regulators, dynamometers, valves, brakes, fly-wheels, governors, measurement of friction, &c. *Water power Engines*,—Sources of water power, measurement of supply. Construction of conduits. Measurements of flow. Hydraulic press. Water pressure engines. *Water Wheels*,—Overshot, undershot, and breast wheels. Reaction wheels. Turbine wheels. Wind power. *Heat Engines*,—Principles of thermodynamics. Air engines. Steam engines. Efficiency of steam and air engines. Mechanism of steam and air engines. Drawing of structures. *Metallurgy*.

(d.) IN AGRICULTURE.

JUNIOR YEAR.

FIRST TERM.—*Theoretical and Organic Chemistry*,—Lectures. *Experimental and Analytical Chemistry*,—in their Agricultural applications. Laboratory Practice. *Physical Geography*. *Mineralogy*,—Blowpipe Analysis and Determinative Mineralogy. *English*. *German*. *French*.

SECOND TERM.—*Agricultural Chemistry*,—Recitations. *Experimental Chemistry*,—Laboratory Practice. *Physical Geography*. *Mineralogy*. Lectures. *English*. *German*. *French*.

THIRD TERM.—*Agricultural Chemistry*,—Lectures. *Horticulture and Kitchen Gardening*,—Lectures. *Experimental Chemistry*,—Laboratory Practice. *Botany and Zoology*,—with Excursions. *Mineralogy*,—continued. *English*. *German*. *French*.

SENIOR YEAR.

FIRST TERM.—*Agriculture*,—Cultivation of the Staple Crops of the Northern States. *Agricultural Zoology*,—Origin and Natural History of Domestic Animals. Insects useful and injurious to Vegetation. *Geology*,—Dana's. *English*. *French*. *Excursions*,—Agricultural, Botanical, etc.

SECOND TERM.—*Agriculture*.—Stock raising and principles of Breeding. *Geology*,—Dana's. *Human Anatomy and Physiology*,—Lectures. *English* *French*.

THIRD TERM.—*Rural Economy*,—History of Agriculture and Sketches of Husbandry in Foreign Countries. Systems of Husbandry. *Geology*,—Dana's. *English*.

(e.) IN NATURAL HISTORY.

(Either Geology, Mineralogy, Zoology, or Botany may be made the principal study, some attention in each case being directed to the other three branches of Natural History.)

JUNIOR YEAR.

FIRST TERM.—*Chemistry*,—Qualitative Analysis. Laboratory Practice. Recitations. *Mineralogy*,—Blowpipe Analysis and Determinative Mineralogy. *Botany*,—Gray's Text-book; Use of the Microscope. *German*. *French*.

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SECOND TERM.—*Zoology*,—Laboratory Practice. *Physiology*,—Huxley's. *Botany*,—Laboratory Practice: Gray's Text-book. *Mineralogy*,—Lectures. *Physical Geography*. *German*. *French*.

THIRD TERM.—*Zoology*,—Laboratory Practice. Lectures, Excursions (land and marine). *Botany*,—Practical Exercises, Excursions. *Mineralogy*,—continued. *German*. *French*.

SENIOR YEAR.

FIRST TERM.—*Geology*,—Dana's. Excursions. *Anatomy of Vertebrates*,—Huxley's. *Zoology*,—Laboratory Practice. Lectures. Excursions. *Botany*,—Herbarium Studies. Excursions. *Linguistics*,—Whitney's Language and the Study of Language. *French*.

SECOND TERM.—*Geology*,—Dana's. *Zoology*,—Laboratory Practice. Lectures. *Botany*,—Herbarium Studies. Cryptogamic plants. Botanical Literature. Essays in Descriptive Botany. *Linguistics*,—Whitney's Language and the Study of Language. *French*.

THIRD TERM.—*Geology*, *Zoology*, *and Botany*—continued, with Excursions. *Meteorology*. *French*.

Besides the regular courses of recitation and lectures on structural and systematic Zoology and Botany, and on special subjects, students are taught to prepare, arrange, and identify collections, to make dissections, to pursue original investigations, and to describe Genera and Species in the language of science. For these purposes, large collections in Zoology and Palæontology belonging to the College are available, as are also the private botanical collections of Professor Eaton.

(f.) IN PREPARATION FOR MEDICAL STUDIES.

During the Junior year, the work of this course will be chiefly under the direction of the instructors in Chemistry. Especial attention will be given to qualitative and quantitative analysis, in their physiological and medical bearings; and to the preparation and study of the organic proximate elements. In the Senior year, the work will be chiefly under the direction of the Professors of Zoology and Botany. Attention will be paid in Zoology to comparative anatomy, embryology, the laws of hereditary descent, and human parasites; and in Botany to a general knowledge of structural and physiological Botany, and to medicinal, food-producing, and poisonous plants. The order of studies is as follows:

JUNIOR YEAR.

FIRST TERM.—*Chemistry*,—Qualitative Analysis, Fresenius'. Laboratory Practice. Recitations. *Mineralogy*,—Blowpipe Analysis and Determinative Mineralogy. *German*. *French*.

SECOND TERM.—*Physiological Chemistry*,—Klein's Handbook. Laboratory Practice. Recitations. *Physiology*,—Huxley's. *Mineralogy*,—continued. *German*. *French*.

THIRD TERM.—*Physiological Chemistry*,—Klein's. Laboratory Practice. Recitations. *Zoology*,—Lectures and Excursions. *Botany*,—Lectures, Practical Exercises and Excursions. *Mineralogy*,—continued. *German*. *French*.

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SENIOR YEAR.

FIRST TERM.—*Comparative Anatomy and Physiology*,—Laboratory Practice. *Anatomy of Vertebrates*,—Huxley's. *Botany*,—Practical Exercises, Lectures, and Excursions. *Geology*,—Dana's. *Zoology*,—Lectures and Excursions. *French*.

SECOND TERM.—*Comparative Anatomy and Systematic Zoology*,—Lectures. Laboratory Practice. *Botany*,—Lectures. Laboratory Practice. *Geology*,—Dana's. *French*.

THIRD TERM.—*Comparative Anatomy and Physiology*,—Laboratory Practice. *Zoology, Botany, and Geology*,—continued, with Excursions.

(g.) IN STUDIES PREPARATORY TO MINING AND METALLURGY.

Young men desiring to become Mining Engineers, can pursue the regular course in Civil or Mechanical Engineering, and at its close can spend a fourth year in the study of metallurgical chemistry, mineralogy, etc.

(h.) IN THE SELECT STUDIES PREPARATORY TO OTHER HIGHER STUDIES.

JUNIOR YEAR.

FIRST TERM.—*Mineralogy*,—Blowpipe Analysis and Determinative Mineralogy. *Astronomy. Physical Geography. English*,—Early English. *History*,—Freeman's Outlines. *French. German.*

SECOND TERM.—*Mineralogy*,—Lectures. *Astronomy. Physical Geography. English*,—Chaucer, Shakespeare. *History*,—Freeman's Outlines, with Lectures. *German. French.*

THIRD TERM.—*Botany and Zoology*,—Lectures and Excursions and Laboratory Practice. *English*,—Shakespeare. *Political Economy*,—Walker's Science of Wealth. *German. French.*

SENIOR YEAR.

FIRST TERM.—*Geology*,—Recitations and Excursions. *Botany*,—Lectures, Excursions and Laboratory Practice. *Zoology*,—Lectures and Excursions. *Linguistics*,—Whitney's Language and the Study of Language. *English*,—Shakespeare. *History*,—Constitutional History of the United States. Lectures. *Political Economy*,—Lectures. *French.*

SECOND TERM.—*Geology and Zoology*,—continued. *Linguistics*,—Whitney's Language and the Study of Language. *Political Economy*,—Lectures. *English*,—Shakespeare and Milton. *History*,—Political History of the United States. Lectures. *French.*

THIRD TERM.—*Geology*.—Recitations and Excursions. *Zoology*,—Lectures. *Meteorology. English*,—Dryden and Pope. *History*,—Lectures. History of Europe since 1848. *Political Economy*,—Lectures.

Exercises in English Composition are required during the entire course from all the students. The preparation of graduation theses is among the duties of the Senior year.

Lectures on Military Science and Tactics are annually given.

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Drawing.

The course in drawing extends through the three years. Dur the first term, and half of the second term of Freshman year, students practice free-hand drawing at the Art School buildi under the direction of Professor Niemeyer, of the Yale Schoo the Fine Arts. After the completion of the course in free-h drawing, instruction is given by Mr. F. R. Honey, during second half of the year, in the elementary principles of instrumer drawing, embracing the whole of Binn's first course of ort graphic projections, and Descriptive Geometry as far as war surfaces. This course is obligatory upon all.

During the Junior and Senior years, instruction in drawing obligatory only on the students in Civil and Mechanical En eering. In the former year the system of instruction embra Binns' second course in orthographic projections, isometric dr ing, shades and shadows, tinting, perspective, and warped faces. By this method all the problems in Descriptive Geome are required to be worked out on the drawing-board instead the black-board. The course extends through the entire y and is under the direction of Mr. Honey,

In Senior year, students are required to apply the principles drawing already obtained to works of construction, under general supervision of the Professors of Civil and of Dyna Engineering.

VIII.

Methods of Instruction.

The instructions of this institution are given chiefly in s class rooms, recitations or familiar lectures, illustrated by apparatus at the command of the various teachers. In m studies weekly excursions are made for the purpose of collec specimens and examining natural phenomena.

In Chemistry and Metallurgy the students work several h daily in well-appointed laboratories, under the direct superin dence of the instructors, and are guided through system courses of quantitative and qualitative analysis, assaying, and blow-pipe determination of minerals and ores.

In Botany, during the summer of Junior year, exercise analyzing and identifying plants occur two or three times a w followed by practice in writing characters and description plants from living specimens. Students are shown also the

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methods of collecting and preserving for future study, specimens of Flowering Plants, Ferns, Mosses, Algæ, &c. In the autumn term of Senior year the work of the summer is continued. Students are encouraged to pursue special lines of Botanical investigation, and varied assistance is rendered them according to their needs. The final examination is intended to show what they have learned, and the collections they have made are considered to be of minor importance.

In Zoology weekly excursions are made during the third term of Junior and first term of Senior year, in company with the instructors, for the purpose of observing the habits and making collections of Marine, fresh-water, and terrestrial animals of all classes. Each student is required to prepare and present for examination a collection containing a specified number of species, and illustrating the various classes of animals. He must also be able to pass an examination upon his collection, at least to the extent of explaining the classes and orders illustrated, and showing why particular specimens belong to the respective classes.

In Geology excursions are made for the purpose of examining geological phenomena and making special collections of rocks and minerals. Each student is required to pass a satisfactory examination on his collections at the end of the first term of Senior year.

In addition to the above, a course of lectures is given every winter by the professors of the school and others, on topics of popular interest.

IX.

Tuition Charges.

The charge for tuition is $150 per year, payable, $55 at the beginning of the first and of the second term, and $40 at the beginning of the third term. The special student of Chemistry has an additional charge of $70 per annum for chemicals and use of apparatus. He also supplies himself at his own expense with gas, flasks, crucibles, etc., the cost of which should not exceed $10 per term. A fee of $5 is charged members of the Freshman Class for chemicals and materials used in their laboratory practice, and the same fee is required from all who take the practical exercises in Blow-pipe Analysis and Determinative Mineralogy. An additional charge of $5 is annually made to each student for the use of the College Reading Room and Gymnasium.

After the present year a fee of $5 a term will be charged to the students in the Zoological Laboratory.

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X.

Church Sittings.

Free sittings for students in this department of Yale are provided as follows:

In the Center Church (Cong.): Pews Nos. 36 and 4 North Gallery.

In the Trinity Church (Epis.): Pews Nos. 175 and 17 North Gallery.

In the First Methodist Church: Pew No. 78, at the hea West Aisle (below)..

Any of the students may occupy a sitting in these slips. who prefer to pay for a sitting for a year, more or less, churches above mentioned, or in any other church of any nation, will be aided on application to the Secretary of Sc

Sittings in the Gallery of the College Chapel are free as fore to the students of this department.

XI.

Degrees.

Students of this department, on the recommendation of t erning Board, are admitted by the Corporation of Yale Co the following degrees. They are thus conferred:

1. Bachelor of Philosophy: on those who complete the three-year courses of study, passing all the examinatio satisfactory manner, and presenting a graduation thesis.

The fee for graduation as Bachelor of Philosophy, includ fee for Triennial Catalogues, Commencement Dinners, etc dollars; unless the person taking the degree is also an aca graduate, when it is but five dollars.

2. Civil Engineer and Dynamical Engineer: The ments for these degrees are stated on pages 19 and 20.

3. Doctor of Philosophy: The requirements for this are stated on page 18.

XII.

Terms and Vacations.

The next academic year begins Thursday, September 1 The vacations correspond with those of the Academical ment, giving two weeks at Christmas, two weeks in the and eleven weeks in the Summer.

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XIII.

Announcement in Respect to State Students.

The scholarships established in this School in consequence of the bestowal upon it of the Congressional grants are designed to aid young men who are in need of pecuniary assistance in fitting themselves for agricultural and mechanical pursuits of life. All applicants must be citizens of Connecticut. In case there are more applicants than vacancies, candidates will be preferred who have lost a parent in the military or naval service of the United States, and next to these such as are most in need of pecuniary assistance: and the appointments will be distributed as far as practicable among the several counties in proportion to their population. The Appointing Board for the current year, consisting of the Board of Visitors of the State and the Secretary of the School, will meet on June 27, 1876, and at or about the same time in the year 1877, due notice of which will be given by publication in every county of the State. All applications should be made previous to that time. Blank forms for application will be sent, when requested, by Professor GEORGE J. BRUSH, Secretary of the Appointing Board.

XIV.

Anniversary.

The Anniversary of the School is held on Tuesday of the Commencement week in Yale College, June 27, 1876, when selections from the graduation theses are publicly read. The degrees are publicly conferred by the President and Fellows of Yale College on Commencement Day.

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Instruction in the Use of the Plane Table,

Contributions to the Study of the New Haven Region,

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Public Lectures,

Anniversary,

Candidates for Degrees,

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TWELFTH ANNUAL REPORT

OF THE

SHEFFIELD SCIENTIFIC SCHOOL

OF

YALE COLLEGE,

1877-78.

PRINTED BY ORDER OF THE GENERAL ASSEMBLY.

NEW HAVEN:
TUTTLE, MOREHOUSE & TAYLOR, PRINTERS.
1878.

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State Board of Visitors.

CONSTITUTING, WITH THE SECRETARY OF THE SCHOOL, THE BOARD FOR THE APPOINTMENT OF STATE STUDENTS.

GOVERNOR.

His Exc. RICHARD D. HUBBARD, Hartford.

LIEUTENANT-GOVERNOR.

His Honor FRANCIS B. LOOMIS, New London.

STATE SENATORS.

Hon. LUCIUS BROWN, Norwich.
Hon. WILLIAM B. BISHOP, Bridgeport.
Hon. LYMAN W. COE, Wolcottville.

SECRETARY OF STATE BOARD OF EDUCATION.

Rev. BIRDSEY GRANT NORTHROP, New Haven.

Councillors.

APPOINTED BY THE CORPORATION OF YALE COLLEGE.

Hon. JAMES E. ENGLISH, New Haven.
Hon. MARSHALL JEWELL, Hartford.
Hon. JOSEPH R. HAWLEY, Hartford.
Hon. OLIVER F. WINCHESTER, New Haven.
JOSEPH E. SHEFFIELD, Esq., New Haven.
Prof. JAMES D. DANA, LL.D., New Haven.
HENRY FARNHAM, Esq., New Haven.
M. DWIGHT COLLIER, M.A., St. Louis.
Hon. WILLIAM E. DODGE, New York City.

SECRETARY AND TREASURER OF THE SCHOOL.

GEORGE J. BRUSH.

JANITOR OF SHEFFIELD HALL.

ANTON PFEIFER, 55 Lock street.

JANITOR OF NORTH SHEFFIELD HALL.

GEORGE W. STODDARD, 407 Columbus street.

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REPORT OF THE STATE BOARD OF VISITORS.

To the General Assembly of the State of Connecticut:

The State Board of Visitors of the Sheffield Scientific School have discharged their duties for the current year, and take pleasure in testifying to the admirable condition and efficiency of the institution, and to the rapid advance which it is making from year to year under its very able and energetic managers. It is an honor to the State, not only as a most distinguished school of higher education in the arts and sciences, but as contributing, even in an economic point of view, to the development and prosperity of our material industries.

The State has twenty-seven free scholarships in this school, to which, when applications are in excess of this number, the Governing Board of the school have been accustomed, as matter of courtesy, to allow three more. These are awarded by the Appointing Board to young men fitting themselves for agricultural, mechanical or manufacturing occupations, by preference to orphans of parents who decease in the naval or military service of the United States, and next to such as are in need of pecuniary assistance in fitting themselves for the above named pursuits. By law they are to be distributed among the several counties of the State according to population. Either through ignorance of these noble provisions, or for some cause less creditable, some of the counties of the State are not only without their proper proportional representation in the school, but without any representation at all. These scholarships, for want of other applicants, are largely shared by the people of New Haven county, who have the good sense to appreciate what the people of too many other counties seem to ignore or undervalue. That such opportunities of higher popular education in one of the most accomplished scientific schools in the country, offered without money and without price, should almost go a-begging here in Connecticut, is not altogether creditable to the State. The Board of

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Visitors take this occasion through the Legislature to remind the
ple of the State that there are twenty-seven gratuitous scholar-
s in this school which belong to them, and that they are to be
by deserving applicants for the asking.

he endowment held by the Commissioner of the School Fund
the use of the Sheffield Scientific School, originally invested
Jnited States bonds, was, in 1866, directed to be invested in
e bonds. Nineteen ($19,000) of these bonds were redeemed
he State in June last. The Commissioner, doubtful of his
iority to reinvest, caused the proceeds to be placed on deposit
per cent. interest. This has resulted in a partial loss of
me to the fund. This loss the State is, by the terms of the
of Congress conferring the fund and of the act of the State
pting it, bound to repair. We recommend the immediate
stment of the fund at the highest rate of interest consistent
i its safety, and that the State meantime make good the
nkage of revenue arising from failure to reinvest.

he report of the Governing Board of the school, which is
to annexed, will supply the Assembly with all needed infor-
ion in regard to the condition, progress and working of the
itution.

y order of the Board of Visitors,

R. D. HUBBARD,
President.

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ANNUAL STATEMENT

OF THE

GOVERNING BOARD.

The Eleventh Annual Report of the Sheffield Scientific School was presented to the Legislature in June, 1876, and embraced the history of the institution during the twelve months immediately preceding. In consequence of the change which had taken place in the time of meeting of the Legislature, no inspection by the State Board of Visitors had been made in the short time which had elapsed between the two sessions of the legislative assembly; and the Governing Board of the School were advised by the then Governor to submit their next report at the opening of the session in January, 1878. The twelfth Annual Report will accordingly embrace an account of the School during the last half of the year 1876, and the whole of the year 1877.

The Peabody Museum.

At the date of the last Report, it was mentioned that the instruction in Mineralogy had at that time been already transferred to the Peabody Museum. This was soon followed by the transfer of the instruction given in various other departments. In the autumn of 1876, the laboratories of Biology (including Zoology and Comparative Anatomy), as well as the laboratories of Geology and Mineralogy, were opened, and from that time all the instruction given by the School in these various subjects has been carried on in the Museum.

Change in the Corps of Instructors.

It is with great regret that the Governing Board are under the necessity of announcing the loss from the corps of instructors of Professor William P. Trowbridge, who in 1877 accepted the position of head of the Engineering Department of Columbia

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College, N. Y., and in consequence resigned the chair of Dynamic Engineering, of which he was the first incumbent. His place was filled at the commencement of 1877 by the election of A. Jay DuBois, who was at that time Professor of Civil Engineering in Lehigh University. Mr. DuBois was graduated at the Sheffield Scientific School in 1869, and pursuing in it for the four following years courses of graduate study, received in 1870 the degree of Civil Engineer, and in 1873 that of Doctor of Philosophy. He subsequently spent two years in Europe in the further prosecution of his special engineering studies, and on his return to this country was called to the chair of Civil Engineering in Lehigh University, and during his connection with that institution wrote a treatise on Graphical Statics, and translated and edited the second volume of Weisbach's Mechanics.

Instruction in Biology as a Preparation for Medical Studies.

The course in Biology, as a preparation for Medical Studies, has now attained to such dimensions, and has proved so decided a success, that it seems eminently proper that in this Annual Report an account should be given of its origin and history, and the objects which it was destined to fulfill. The insufficiency of the preparation of most of the students who attend our medical schools and the generally admitted low standard of medical education, resulting very largely from this want of preparation, had early attracted the attention of the Governing Board and led them, after considerable deliberation, to arrange, and to announce in the Annual Report for 1869–70, a new course of instruction intended specially to provide efficient preparation for medical studies. Several students at once availed themselves of the opportunity thus offered, and in 1872, two were graduated and at once entered upon their strictly professional studies. Since the first announcement important changes have, from time to time, been made in the instruction given, and there has been a constant increase in the number of regular undergraduate students taking the course, while a considerable number of graduate and special students have pursued the whole or a part of the studies prescribed. Still it is believed that the advantages of such a course of study are not so well nor so widely understood as they deserve to be, and that it is desirable that a fuller statement of the aim and object of the course should be made.

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That some preparation beyond that usually acquired at the "common school" is needed for profitable entrance upon medical studies is taken for granted. Even those medical schools which practically require no examination for entrance, usually recognize this in the shortening of the required term of study for those students who have received a baccalaureate degree. In one sense, any course of study, in as much as it is disciplinary, is a preparation for medical as well as for any other studies, but no argument is needed to show that purely mental training, which may be the best preparation for theological or legal studies, for instance, is a very imperfect preparation for the study of medicine. As a rule, the student while at the medical school has very little time or opportunity for the training of the senses and the acquisition of the power of accurate observation which are so evidently requisite in the practice of medicine or surgery. And if this special training is essential to the successful practice of medicine, it is also an almost indispensable aid in the acquisition of the technical knowledge and skill required of the practitioner. The training which is to furnish the special discipline for the practice of medicine or surgery should therefore as largely as possible precede the medical studies themselves. The study of the methods of modern scientific investigation and their practical application in the laboratory, unquestionably furnish the best and readiest means for this kind of training. A still more apparent advantage of this class of studies is that they may readily be made to furnish the best groundwork for the special medical education. The shortness of the usual term of instruction in the medical schools does not allow the introduction of even the most essential preliminary studies, so that the ordinary student is often forced to take up studies which he is not qualified to pursue. As an illustration, a thorough acquaintance with the elements of physics and chemistry is essential for understanding the first principles of physiology, and yet neither physics nor chemistry has properly any place in the curriculum of the medical school, and cannot well be taught the student already grappling with subjects presupposing a knowledge of them. The elements of these important studies should be mastered before the medical school is entered, and when studied practically in the laboratory, as only they can properly be studied, they also give training in scientific method and manipulation, which is so essential both to the student and practitioner of medicine.

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There is no necessity for discussing the need of general literary and scientific studies in a course of preparation for the medical school. In the Scientific School such studies run through all the courses of instruction and are made obligatory upon all students. The knowledge of German and French thus acquired is also of special additional value to the medical student by enabling him to make use of the important technical works in those languages.

A brief outline of the course of instruction in biology as now conducted is given in the Programme of Studies accompanying this Report, but a somewhat fuller explanation of that portion of the instruction bearing particularly upon medical pursuits may properly be given here. During the first year, which is introductory to all the courses, besides German, English and mathematics, the student has recitations and experimental lectures in physics, elementary chemistry with practical work in the laboratory, elementary drawing, and elementary botany, and also lectures on physical geography and political economy. With the second year the special biological studies begin, and during the rest of the course the student spends a portion of each day in practical work in the laboratory.

During the entire second year the laboratory work for five days in the week is confined exclusively to chemistry: the first term to inorganic, the second to physiological and toxicological chemistry. At the beginning of the year the student who, from his study of elementary chemistry is prepared to enter understandingly upon a course of laboratory work, is taught the reactions of the different elements of inorganic matter and to verify by actual observation the statements made in the text book concerning the elements studied. Thus habits of observation, so important to a medical man, are formed and the power of tracing to their rightful sources many of the phenomena of nature, together with a knowledge of inorganic chemistry, is acquired: a necessary step preceding the more important study of the chemistry of the body. After a certain amount of work has been performed in the study of reactions, unknown substances are given the student to analyze, thus calling into use the knowledge acquired and familiarizing him with the *modus operandi* of qualitative analysis while at the same time habits of self-reliance are formed. The plan of thus working out results in the laboratory by the aid of established facts not only serves as a drill in the manipulation and practical workings of chemical analysis, but also has the good effect of fixing the facts themselves in even the most obtuse mind.

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Having spent one term of the year in the study of inorganic chemistry in the form of qualitative analysis, the student is removed to a laboratory fitted up especially for the study of physiological chemistry, where the chemistry of the body is as thoroughly studied as the amount of time will allow. Each student, supplied with the necessary apparatus and reagents, separates for himself, under the guidance of an instructor, the proximate principles from the different tissues and fluids of the body, examines and compares them one with another, studies their individual characteristics and familiarizes himself with all their properties. Commencing with albuminous matter, students are carried on in their work to the chemical examination of connective tissue, muscular tissue, flesh extracts and brain tissue. Blood and bile are likewise examined. Students also study the urine in health and disease, making microscopic examinations of deposit, learning to distinguish casts, and familiarizing themselves with all other abnormal appearances, and finally they are taught to make a complete analysis of this most important diagnostic fluid.

The value of such a course of study preliminary to medical studies cannot be overestimated. Too little attention is paid to physiological chemistry in our medical schools; not perhaps so much from a lack of appreciation of its value as from a lack of time; the more pressing need of proficiency in anatomy, surgery, and kindred subjects not allowing time for its study. In the curriculum of most medical schools we see chemistry as one of the subjects taught, but a little investigation will reveal the fact that the chemistry so taught is crowded into a term's work, and that of the most elementary character to supply the need of students not versed in the first principles of this most important science. The remedy lies not so much with the medical school, unless it be in demanding a more thorough and suitable preparation, as with the preparatory course.

Again the microscopic examination of crystals, sections of calculi, blood crystals and corpuscles, fluids, and solids in health and disease constitutes an important feature of this course and one the importance of which will be at once recognized. Besides practical work in this direction a course of lectures on the use of the microscope is delivered by Professor Brewer during the second term. Laboratory work in physiological chemistry is supplemented by recitations and lectures on the classification of the proximate principles. Instruction is also given in toxicology, a subject to which

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our medical schools have time to pay but little attention. Both the mineral and alkaloid poisons are carefully studied, their principal reactions are worked out and students are taught how to apply delicate tests and to separate both the mineral poisons and alkaloids from organic mixtures. Lectures are also given on the classification of poisons, methods of preparation from the vegetable and mineral kingdoms, effects on the animal system, fatal dose, and antidotes. Arrangements are also made whereby graduate students can spend a portion of another year in quantitative analysis of urine and in supplementing their knowledge of toxicology.

During the third year the laboratory work for either four or five days in the week is devoted specially to comparative anatomy and histology. The student himself dissects specimens of a number of different animals and is required to make careful sketches and records of his work; he also examines the different animal tissues with the microscope, makes microscopical preparations and is taught the methods of anatomical and histological investigation. The object sought is not so much the storing of the mind with the minor facts of anatomy as training in the methods of the investigations by which the facts and principles of anatomy and histology have been established. Still the anatomy and histology of the higher animals is so nearly identical with that of man that all the more important features in the structure of the human body may be learned from the dissection of common animals, and so the knowledge of anatomy acquired is an important direct assistance to the student in the lecture or dissecting room of the medical school. Much stress is laid upon the acquisition of facility in the use of the microscope, not only on account of the extensive and increasing use of this instrument in medical practice, but also because it familiarizes the student with the use of delicate and accurate instruments and trains the hand and eye to their use. Instruction, by means of recitations accompanied by demonstrations and practical exercises, is given in human physiology and in the general anatomy of the higher animals, with the view of fixing the elementary principles of these subjects in the mind. The laboratory work one day each week, for two-thirds of the year, is given to the practical study of botany, in which instruction is also given by lectures. During the year instruction by lectures is given also in systematic zoology and in the laws of heredity and the principles of breeding.

A special effort is made to have the thesis, which every student

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is required to prepare before graduation, based on some original investigation carried out by himself, in order to give him, if possible, that experience and self-reliance which can come only from independent work, and that discipline which is gained by the systematic arrangement and presentation of any series of facts. This effort has succeeded so well that several of the theses of the graduates in this course have been essays of permanent scientific value.

For the practical work in comparative anatomy, etc., a large and excellently lighted laboratory in the Peabody Museum furnishes ample accommodations. Professor Eaton's laboratory in North Sheffield Hall affords similar facilities for botanical work. Students are supplied with microscopes and the materials needed to prosecute their practical studies. While it is not believed that the instruction in this course thus far has materially suffered from the want of apparatus and the means of illustration necessary for the use of the students and the instructors, there is urgent need of some permanent provision for such wants, which it does not at present seem possible to meet from the available funds of the school. Such provision would become a necessity should the number of students selecting this course be much increased, for all the microscopes and much of the other apparatus of instruction used in one of the departments of the course are at present furnished at the private expense of one of the instructors, who cannot be expected to increase the amount of such expenditure.

Connecticut Agricultural Experiment Station.

At its last session, the State Legislature authorized the establishment of the Connecticut Agricultural Experiment Station, with a Board of Control consisting of eight members, one of whom, by the provisions of the act, was to be elected by the Sheffield Scientific School. In accordance with this requirement, the Governing Board chose as a member of this body Professor Wm. H. Brewer. As this School was already, and was designated by statute as the State College of Agriculture and the Mechanic Arts, there seemed to be a special propriety on its part in offering accommodations to the Station. This was accordingly done, and the offer was accepted by the Board of Control. Professor S. W. Johnson, who held the chair of Agricultural Chemistry in this School, was elected Director of the Station, and the following changes were made in the arrangement of the room in Sheffield Hall for its accommoda-

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tion. The two rooms, closet and vestibule on the first floor of the east wing, lately occupied by the Mineralogical Laboratories, were rearranged and fitted up for the use of the Station, the changes and sewer connections made necessary by this involving a direct outlay for plumber, gas-fitter and carpenter bills of about $550. In addition, all the apparatus used in the laboratory, except such as has been constructed for special investigations, and those owned by the officers of the Station, has been loaned by the School thus far, without which it would have been simply impossible to carry on the analytical and other chemical work which it was required to perform. To make the accommodations as complete as possible, Room No. 1, heretofore used as a recitation room for mathematics, has been given up to the chemical department, and the instruction in mathematics has been transferred to North Sheffield Hall.

Funds.

The general prostration in the business interests of the country, and the consequent decline in the value of investments having to a certain extent affected the resources of the School, the Governing Board felt it necessary to take some decided action towards keeping the expenditures within the income. No other resource seemed to them to be open, without injuring the efficiency of the institution, than to cut down their own salaries; and accordingly at the Commencement of 1876, the permanent professors of the School gave up each $400 of his salary. The reduction went into effect the following Academic year, and is likely to be necessary for several years to come; and has, moreover, been followed by a reduction of all the running expenses of the institution to the very lowest point compatible with a successful prosecution of the studies of the various courses.

In connection with this, one important fact needs to be brought to the attention of the Legislature.

The income of the School from the fund derived from the sale of public lands, given to the State by Congress for the aid of Colleges of Agriculture and the Mechanic Arts, has this year been somewhat diminished by the circumstance that the State Treasurer has paid off certain of the State Bonds in which the fund was invested. The Commissioner of the School Fund, to whom this fund is intrusted by the State, has assumed that he has not power to re-invest without further legislative action, and it is presumed, if necessary, such action will be taken by the legislature, and the

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deficit of interest will be made good to the institution. By the Act of Congress under which the State received this gift, it is provided that "If any portion of the fund invested, or any portion of the interest thereon, shall by any action or contingency be diminished or lost, it shall be replaced by the State to which it belongs, so that the capital of the fund shall remain forever undiminished, and the annual income shall be regularly applied without diminution to the purposes mentioned." . . . . .

Gifts.

During the past year the institution has received a legacy of £1,000, the gift of the late Mrs. Susan K. Higgin, of Quarry Bank, West Derby, Liverpool. The trustees of this fund have directed that it should be added to the former generous gift of £5000 made by Mrs. Higgin in 1871, and that the income of the whole amount should be devoted to the support of the Higgin Professorship of Dynamic Engineering. The Corporation have also received in trust for the Scientific School a legacy of five hundred dollars from the estate of the late Morris Tyler.

It ought perhaps also to be added here, that the executor of the estate of the late Edward A. Mitchell, has paid to the Treasurer in advance the balance of four years subscription to the income of the School, six annual payments of two hundred and fifty dollars having been made during Mr. Mitchell's lifetime.

Through the generosity and energy of Mr. Willard N. Pratt, of the Class of 1877, the geological collection has received a very large fossil-tree stump from the mines of the Blossburg Coal Company at Arnot, Tioga Co., Penn. The specimen was exhumed about three-quarters of a mile from the entrance of the mine, and 229 feet below the surface of the mountain. It is twenty-six inches in diameter at the top and the roots spread out two or three feet on each side, making it seven to eight feet in diameter at the base. The whole weighs over two tons, and the specimen is now deposited for exhibition in the main hall of Peabody Museum. Mr. Pratt not only incurred the expense of getting out this grand specimen, but gave the matter his personal superintendence and secured its free transportation by railroad to New York City.

From the United States Department of Agriculture, a collection has been received of specimens of woods of the United States, amounting to one hundred and thirty-four (134) species, collected

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under the direction of Dr. Geo. Vasey, of the Botanic Department. The specimens have been placed on exhibition in the east wing of Sheffield Hall.

From Dr. José de Saldanha, Director of the Botanic Gardens of Rio Janeiro and late Brazilian Commissioner to the Centennial Exhibition, a gift was received of Brazilian ornamental woods, fibres, rubber and other crude forest products.

A collection of starches from a considerable number of species, from the collections of several countries at the late International Exhibition, and representing a considerable number of species, has also been added to the chemical collection.

Additions to the Zoölogical Collections.

A. E. Verrill, Curator; W. H. Patton and E. B. Wilson, Assistants.

During the eighteen months, since the last report was written, all the available time of the curator has been devoted to the moving of the Zoölogical collections, which were previously stored in several different buildings, into the Peabody Museum and to overhauling, storing, and arranging them there. A large amount of time was also devoted, both by Professor S. I. Smith and the curator, to the making of the plans for the cases and other furniture of the Zoölogical department (third floor) of the museum. The summer vacation of 1876 was also devoted to moving the collections and similar work. Consequently the curator has been able to do, during all this time, very little in the way of scientific investigation, nor has he been able to keep up, to any great extent, the system of exchanges. At the present time, however, the cases in the Zoölogical department are nearly all filled and the arrangement of the collections is well advanced. In the arrangement of the collection the curator has been greatly aided by Professor S. I. Smith, who volunteered to arrange the crustacea; by Mr. Patton, who has taken charge of the insects; and by Mr. Wilson, who has assisted in arranging the shells, fishes, reptiles, &c. Professor W. D. Whitney and Mr. C. H. Merriam have also given assistance in the identification and arrangement of the birds. We are also much indebted to the skill of Mr. E. H. Hawley, who has neatly mounted many of the corals and other specimens.

During the last summer vacation, the curator, by invitation of Professor S. F. Baird, Commissioner, took charge of the dredging

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operations of the U. S. Commission of Fish and Fisheries, as in previous years. Mr. E. B. Wilson acted as special assistant, during this expedition. Very extensive explorations, both with dredge and trawl, were made in Massachusetts Bay, off Salem; in the deepest parts of the Gulf of Maine; off Nova Scotia; and near Halifax. Many very interesting additions to the American fauna were made, both of fishes and invertebrates, and very extensive collections were obtained. All of the invertebrates, as in former years, were deposited here for examination and reports, and for subsequent distribution of the duplicates to other museums, when a complete series will be retained here and deposited in the museum by the curator, as a part of the special collections designed to illustrate the Zoölogy of New England.

Professor W. D. Whitney presented a very valuable collection of about 160 New England birds, beautifully mounted by himself, and deposited for several years past in the Scientific School. He has, also, recently made several additions to it,—among them a golden eagle. This collection includes a wild turkey, killed on Mt. Tom, Mass., Nov., 1847, which is believed to be the last one known to have been observed in New England. This collection will form part of the special collection of New England birds.

The curator has deposited in the museum a series of about 125 birds, collected and mounted by Mr. C. A. Houghton, at West Medway, Mass., which also now form a part of the New England collection.

Mr. Houghton has also mounted for the museum, in a very satisfactory manner, a considerable number of foreign birds, from dry skins.

The Yale Medical Institute has transferred to the museum the collection of native and foreign birds, for many years deposited in its museum by the Yale Natural History Society. There were nearly 100 native birds, mostly collected near New Haven, about 1837, and several water birds, from Stratford, Conn., collected by Rev. James H. Linsley, near the same time. These were in fair condition. The foreign birds (about 150 in number) were very badly damaged by moths, so that 112 were transferred to the Osteological department. These were from the East Indies (bought at Singapore) and presented by Mr. Peter Parker, about 1835.

The Medical Institute also presented a large collection of stuffed fishes, prepared at Santa Cruz, W. I., by Dr. E. H. Bishop;

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several stuffed reptiles; Gorgoniæ, corals, etc., from Bermuda; a lot of foreign shells.

Professor G. Brown Goode, Middletown, has sent to the curator for examination and report a very large and valuable collection of Corals, Echinoderms, Hydroids, Actiniæ, etc., collected by him at Bermuda. Eventually a good series of all these will be deposited in the museum by the curator. The corals at present fill a special case in the west room. The Crustacea were also sent here, to be studied by Professor Smith.

Professor Goode also sent a collection of fresh water Crustacea from Florida and the Potomac River.

Professor James Orton, of Vassar College, sent the curator a collection of Echinoderms, Crustacea and Annelids from Peru, for determination, and presented duplicates of several interesting species, among them a new and remarkable form of cestode worms, now deposited in the museum.

Mr. W. H. Dall sent for examination portions of a gigantic new ten-armed Cephalopod (*Ommastrephes gigantea* Dall) from the coast of Alaska. Its body was over six feet long.

Rev. M. Harvey, sent to the curator for study a beak of another gigantic Cephalopod (*Architeuthis*) from Newfoundland; and also suckers from the large specimen now on exhibition in the New York Aquarium. He also sent a specimen of the "whalebone" from the throat of the basking shark.

The Poughkeepsie Society of Natural History sent specimens of a new star-fish (*Astrophyton australe* Verrill), and a rare coral (*Primnoella*), from Tasmania.

Mr. M. Mailhouse (S. S. S.) and Mr. R. J. Gibson (S. S. S.), gave specimens of *Calianassa Stimpsoni*, from New Haven.

Mr. S. F. Clark (S. S. S.) presented several fine lots of Hydroids from the vicinity of New Haven.

Mr. S. S. Blodgett sent a gar-pike from Ogdensburg, N. Y.

Mr. C. A. Logan, U. S. Consul to Chili, presented a fine skin of a male condor, which has since been mounted.

From the Museum of Comparative Zoölogy, we have received a valuable collection of fishes, labeled by Dr. Steindachner, and mostly collected by the Hassler Expedition. From the same museum we have received a few rare Ophiurans, in exchange.

Mr. J. F. Whiteaves, Montreal, sent a few Hydroids and Crustacea from Vancouver Island.

Mr. W. H. Dall gave a series of type specimens of Hydroids

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from the collection made by him in Alaska and recently described by Mr. S. F. Clark, by whom our series was selected and labeled.

Mr. S. A. Forbes, Normal, Ill., sent a small number of fresh-water Crustacea for examination.

Mr. C. J. Monson, New Haven, gave a small lot of native reptiles.

A. E. Verrill, various insects, spiders, &c., New Haven; Annelids, Crustacea, etc., Savin Rock; eggs of ruffed grouse, near New Haven, (deposited); rare fishes (among them *Icleus uncinatus*, *Lycodes Verrillii*, *Glyptocephalus cynoglossus*, *Raia radiata*) collected by the U. S. Fish Commission, off Salem and Nova Scotia, (deposited); two squirrels, muskrat and weasel, collected by C. A. Houghton (deposited); Echinoderms from Bermuda, (deposited).

Mr. Fred. S. Smith (Y. C.) presented many lernean parasites on the bream (*Pomotis*) from New Haven.

Mr. Arthur Baldwin, New Haven, presented a collection of birds' eggs.

Mr. Horace Bowman and Mr. J. Rice, each gave a bill-fish (*Belone*) from New Haven.

Mr. Elmore Smith presented a pipe-fish, from New Haven.

Mr. Geo. C. Grooms gave a fish (*Argyriosis vomer*), rare in our waters, from off Madison, Conn.

Mr. Edw. T. Owen, Hartford, has given a collection of insects from China, and also interesting specimens from Hartford, &c.

Mr. E. J. Lake presented a large lot of insects from Illinois and Connecticut.

Small collections of insects have been received from W. H. Patton, S. W. Williston, C. H. Merriam, G. E. and A. H. Verrill, E. B. Barber, Prof. S. I. Smith, Prof. W. H. Brewer, W. A. Silliman, Mrs. E. C. Bradley, A. Daggett, Jr., O. Harger, W. Hamilton, E. Crisand, Mr. Morton, Prof. D. C. Eaton, T. A. Bostwick, J. M. Bishop, F. S. Smith, A. Van Name, T. S. Gold, and others.

Mr. H. H. Curtis (S. S. S.) presented some interesting gorgoniæ, echinoderms, and shells from Nassau, N. P.

Mr. W. E. Gard (S. S. S.) presented a collection of shells from S. Africa.

Mr. C. H. Merriam (S. S. S.) gave in exchange, specimens of rare native birds; and of *Asterias littoralis*, from Eastport, Me., with the young attached around the mouth.

Mr. L. C. Bragg (S. S. S.) presented a large collection of parasitic worms (*Ascaris* and *Echinorhynchus*) from the hog, and also fœtal pigs.

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Mr. C. K. Mixter (S. S. S.) gave a starfish, *Asterias Forbesii*, with two madreporic plates and six rays, from New Haven.

Mr. F. J. Martin (S. S. S.) gave, in exchange, a file fish, from New Haven.

Mr. E. B. Wilson (S. S. S.) presented specimens of crustacea, fishes and insects.

From the Boston Society of Natural History we have received, in exchange, large and fine specimens of *Primnoa reseda* and *Paragorgia arborea* from the Grand Banks, and a collection of sponges, identified by Prof. A. Hyatt, who has also returned a portion of our collection sent to him for study.

From the U. S. Commission of Fish and Fisheries we have received several lots of invertebrates, collected by V. N. Edwards, at Wood's Hole, Mass. Among these there is a fine *Octopus*, new to New England waters, and also a species of *Scyllæa* (allied to *S. Grayi* Ad.), entirely unknown previously on the American coast (deposited).

From the Smithsonian Institution we have received, for examination, a lot of invertebrates from Florida, collected by Prof. S. F. Baird; also several lots from various localities.

Mrs. M. Kimball presented a living "horned toad" from Texas.

Mr. E. T. Green, Oakland, Cal., presented a living "Tarantula" in its tubular nest. After the death of the parent, 95 living young were taken from the nest.

Mr. H. H. McIntyre gave a large skate's egg and a lot of hydroids from St. Paul's Island, Alaska.

Mr. N. T. Bacon (S. S. S.) gave a puffing adder, New Haven.

Miss Carrie Atwater, New Haven, presented a living sharp-shinned hawk.

Miss Helen Lennebacker, Santa Barbara, Cal., sent a very interesting collection of ascidians, hydroids, &c.

Mr. Hunter Nicholson, Knoxville, Tenn., sent phrygania larvæ, which by making crescent-shaped webs on ledges in streams, retain pebbles and cause them to wear small pits in the rock.

Dr. D. B. Delavan, New York, deposited a large specimen of coal (*Dendrophyllia nigrescens*) from the Hawaian Islands. It has been bleached, mended and mounted since it was received.

Mr. John Tiernan presented a rare actinia (*Paractis rapiformis*) from the mouth of the Quinnipiac River, Fair Haven.

Mr. J. Matthew Jones, Halifax, presented a series of dry echinoderms, from Bermuda; also various invertebrates from Nova Scotia; mammals from Halifax, &c.

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Provincial Museum, Halifax, sent for examination fragments of sponges and corals, and suckers of a new cuttle-fish (*Architeuthis*) from Cape Sable, N. S.

Mr. G. B. Grinnell gave four rare birds from Milford, Conn.

Mr. R. T. Morris presented an "old squaw" and least bittern, from New Haven.

Prof. S. Wells Williams gave an emerald bird of paradise, and a king bird of paradise (*Paradisea regia*) from the East Indies.

Mr. A. H. Thompson presented a little auk (*Mergulus alle*) from near New Haven, (prepared by G. B. Grinnell).

Prof. C. F. Hartt, Geol. Survey of Brazil, sent to the curator, for identification, an interesting lot of gorgoniæ and corals from Brazil, (deposited).

Another lot, sent for identification, was received from the Bermuda Centennial Commission.

Owing to the urgent character and great amount of museum work that needed to be done at once, only a few collections have been sent away in exchange during the year, and only a part of those sent here for examination have been returned, much to our regret. Among the collections sent away are the following:

Two collections of Crustacea and two of Echinoderms sent to the Museum of Comparative Zoölogy, in exchange.

A collection of Bryozoa presented to Mr. C. F. Cox, together with a lot of specimens, determined by the Curator and returned.

A collection of Bryozoa determined by the Curator and returned to Prof. A. Hyatt.

Collections of Crustacea, Mollusca, sponges and star-fishes sent to Prof. S. F. Baird for the Centennial Exhibition.

A collection of Crustacea from Bermuda, sent by G. Brown Goode, has been determined by Prof. S. I. Smith and returned.

A collection of Crustacea, labelled by Prof. S. I. Smith, and one of Hydroids, determined by Mr. S. F. Clark, both from Vancouver Island, have been returned to Mr. J. F. Whiteaves.

Several collections of fresh-water Crustacea, insects, &c., have been determined by Professor Smith and returned to different parties.

Portions of the *Architeuthis dux* loaned to the Curator by the Museum of Comparative Zoölogy, have been returned; and several star-fishes (among them *Asterias stellionura*) from off Nova Scotia, have been sent in exchange.

The jaws of *Architeuthis princeps* V., loaned to the curator for

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description and figures, have been returned to the Peabody Academy of Science, Salem.

Collections of sponges have been sent to Prof. A. Hyatt for study, and part of them have been returned.

The crustacea belonging to the family Alpheidæ were sent to Mr. Kingsley, Salem, Mass., for study, and have been returned by him.

A collection of Annelids was given to Prof. H. G. Webster, Union College, in exchange.

A collection of corals and echinoderms was sent to Wesleyan University, in exchange.

The entire collection of North American spiders has been sent to Mr. J. H. Emerton, Salem, Mass., for study, and part of them have been labelled and returned.

A collection of Crustacea, Pycnogonids, Echinoderms, Bryozoa and Sponges has been sent to Rev. A. M. Norman, in exchange.

Series of marine invertebrates, from the collection of the U. S. Fish Commission, have been given to the Peabody Academy of Natural Science, Salem, Mass., and to the Provincial Museum of Nova Scotia; also a few specimens to the New York Aquarium, and to Mr. W. H. Dall.

A small collection of amphibians and specimens of *Malacobdella* was presented to Prof. Carl Semper.

A large stuffed head of the elk, formerly presented by Prof. O. C. Marsh, was returned to him by special request.

A small collection of bird skins was given to Mr. C. H. Merriam, in exchange.

A number of books, chiefly serials, belonging to this department, have been deposited in the College Library.

Contributions to the Study of the New Haven Region.

To the courtesy of Mr. Bache, of the United States Coast Survey, the Governing Board are under renewed obligations for a report of the progress of the work of surveying the New Haven region. Operations, it must be stated, have been largely circumscribed in consequence of the lowness of appropriation by which all government works have been affected; and as, moreover, late instructions from Washington prevent any further extension of the work in this region, this report will be a final one.

"The season's field-work, given in the Annual Report for 1875–76," says Mr. Bache, in his communication to the Board, "was followed by office work, in which Mr. Andrews, graduate of

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the School, was employed; and temporarily, also, Mr. Bogart, a graduate, who was then discharged for want of means to keep him. Mr. Gillette, undergraduate, also assisted for a short time in the draughting.

"Early in the spring of 1877, Messrs. Gillette and Bogart, alternately, ran contouring lines over the country around Lake Saltonstall, of which the horizontal survey had been made during the preceding season; and Mr. Andrews determined a few points by triangulation, to meet the season's prospective topography.

"At the beginning of July, a small additional appropriation became available for work, but not more than upon the most moderate basis. Consequently we were not able to employ more than two or three persons during the season, making a proportional reserve for office work. Mr. Bogart took charge of a plane-table party, assisted by Mr. Gillette, and by Mr. C. McKibben Craig, graduate of the School, which party first filled in some unfinished spots in the Woodbridge Valley, and then surveyed the country northwest of Centreville, including the part of West Rock Ridge near and at the gorge that lies under the spur known as High Rock, in which crosses the only communicating road over the ridge between the New Haven Plain and Woodbridge Valley.

"The details of this triangulation and topography are as follows:—The triangulation added five points, situated on high hills in Hamden. The Giant's Head is the knob on the western part of Mt. Carmel. Of these points, only Howard, No. 2, can be occupied as a station, the rest being points in trees, marked with flags. Howard, No. 2, is marked with a large stake and a pile of stones.

Geographical Positions.

	Latitude.			Longitude.		
Long Hill,	41°	24′	06″.245	72°	53′	09″.702
Giant's Head,	41	25	33.765	72	53	59.207
York Hill,	41	24	30.003	72	55	09.943
Howard, No. 2,	41	24	49.086	72	52	33.172
Brethren,	41	24	51.120	72	55	48.847

Distances between the Points.

	Metres.
Long Hill to West Rock North,	6,744.2
Long Hill to Rabbit Rock,	7,219.6
Giant's Head to West Rock North,	7,137.3
Giant's Head to Rabbit Rock,	10,153.7
York Hill to West Rock North,	4,608.3
York Hill to Rabbit Rock,	9,246.8
Howard, No. 2, to Rabbit Rock,	8,223.5
Howard, No. 2, to High Rock,	5,092.7
Brethren to Rabbit Rock,	10,314.4
Brethren to Howard, No. 2,	4,544.3

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Topography.

the country around Lake Saltonstall, there was executed ıount of ten and six-tenths (10.6) square miles of contouring ıe water-level. In Woodbridge Valley, and in Hamden and ıy, in the localities before specified, the work executed was ɔws:

Square miles (Woodbridge Valley),	0.10
Square miles (Hamden and Bethany),	4.96
Length of main roads,	10.75
Length of secondary roads,	12.00
Length of brooks,	13.90

e maps of the whole area surveyed since we came here (eight), fully completed in drawing, will all be sent to the Coast office before the end of December."

Public Lectures.

eleventh annual course of lectures to mechanics and others iven during the past year in the lecture-room in North ld Hall. The lecturers and their subjects are indicated in nexed programme.

hurs.,	Feb. 8.	Forests and Forest Products,	Wm. H. Brewer.
on.,	" 12.	Mosses,	D. C. Eaton.
hurs.,	" 15.	Forests and Forestry,	Wm. H. Brewer.
on.,	" 19.	Graphics,	F. R. Honey.
ıurs.,	" 22.	Tea,	D. C. Eaton.
on.,	" 26.	Our Red Sandstone,	G. W. Hawes.
ıurs.,	March 1.	The Usury Laws,	F. A. Walker.
on.,	" 5.	Methods of preserving Timber from Decay,	W. H. Brewer.
hurs.,	" 8.	Fermentation and Putrefaction.	S. W. Johnson.
on.,	" 12.	The relations of Sound and Sense,	Mark Bailey.
hurs.,	" 15.	Sanitary Engineering,	W. P. Trowbridge.
on.,	" 19.	Some of the Phenomena of Heat,	J. J. Skinner.
hurs.,	" 22.	The Zoological Department of the Peabody Museum,	A. E. Verrill.

ldition to these, an interesting and valuable course of lec- n Military Science was delivered to members of the Senior ınd others, by officers from the U. S. Engineering School, at 's Point, as a part of the instruction in the school during ar 1876. The order and subjects of the lectures were as ɔ:

r	2.	War Material, — Maj. King.
	5.	Strategy and Grand Tactics, — Capt. Livermore.
	9.	Permanent Fortifications, — Lieut. Bass.
	11.	Torpedoes, — General Abbott.
	16.	Field Fortifications, — Lieut. Rossell.
	18.	Passage of Rivers, and Military Bridges, — Lieut. Symonds.

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Anniversaries.

o anniversary exercises have been held since the publicatior
last Annual Report. The first of these was on the evening
esday, June 27, 1876. Nine theses were selected for public
ng.

e candidates for degrees, with the subject of their graduat-
heses, are given in the following schedule. Those marked
an asterisk were read in the evening.

CANDIDATES FOR DEGREES,

WITH THE SUBJECTS OF THEIR GRADUATION THESES.

BACHELORS OF PHILOSOPHY. (49)

Root Alden (Civil Engineering), *Westville.* A Review of the Risdor
rbine.

Warren Allen (Civil Engineering), *Jersey City, N. J.* Five Designs o
Dam to Resist a Thirty-foot Head of Water.

Marcelon Andrews (Civil Engineering), *Norwich.* On Compressed Ai
a Motive Power.

es Eben Bacon (Civil Engineering), *Middletown.* On Improved Method
Driving Piles.

s Loring Brace (Civil Engineering), *Hastings, N. Y.* On the New Haver
ater Works.

Elwood Brown (Civil Engineering), *West Haven.* On the Application o
eam Power to Canal Navigation.

m McCulloh Brown (Chemistry), *Brookline, Mass.* On the Fossil Iror
es of West Virginia.

C. Browning (Chemistry), *Norwich.* On the Hydraulic Cement of Wood
idge, Ct.

r Cleveland Butler (Civil Engineering), *New Haven.* A Review of the
one Bridge over Mill River at New Haven.

Joseph Caswell (Civil Engineering), *Norwich.* An Investigation of the
mping Apparatus at Whitneyville, Conn.

Henry Chapman (Civil Engineering), *New York City.* A Partial Discussior
the International Art Gallery at Philadelphia.

Williams Clark (Select), *Hartford.* On the Culture and Manufacture o
tton in the United States.

Moffat Cunningham (Civil Engineering), *Poughkeepsie, N. Y.* On the Blak
one Crusher.

rick Perkins Dewey (Chemistry), *West Haven.* On the Separation o
n and Antimony.

ge Cornwall Dunham (Civil Engineering), *Southington.* A Review of the
ew Quinnipiac Bridge at Fair Haven.

ey Forbes (Civil Engineering), *San Francisco, Cal.* On Tidal Motive Power
d Livingston Ford (Civil Engineering), *Buffalo, N. Y.* On the Interna
onal Bridge at Buffalo, N. Y.

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PORTER DWIGHT FORD (Civil Engineering), *Washington.* A Review of the Draw Span in the Bridge at Providence, R. I.

EDWARD JASPER FRANCKE (Chemistry), *New York City.* On the Composition and Method of Analysis of Raw Sugars.

*ROBERT JACKSON GIBSON (Medical), *New Haven.* On the Anatomy of *Callianassa ıpsoni.*

.YS HAMMOND (Select), *San Francisco, Cal.* On the Indian Question.

LAWRENCE HOUGHTELING (Select), *Chicago, Ill.* On the Climatic Effects 'orests.

. HUNT (Civil Engineering), *New Orleans, La.* On the Improvements at th Pass, Mouth of the Mississippi.

HINE JOHNSON (Select), *Brooklyn, N. Y.* On the New England Con- ıration of 1643.

'EWKSBURY LAW (Select), *Tarrytown, N. Y.* On the History of Direct ation in the United States.

HOWARD LINSLEY (Civil Engineering), *West Meriden.* On the Application lity Water Power to Small Motors.

ANCIS LUBY (Medical), *New Haven.* On the External Anatomy of the rn (*Palæmonetes Vulgaris*).

MORGAN MCCLUNG, B.A., East Tennessee University, (Chemistry), *Knox- , Tenn.* On Schorlomite from Magnet Cove, Arkansas.

SUTTON MACGREGOR (Select), *New York City.* On the Factory Laws of gland.

AILHOUSE (Medical), *New Haven.* On the Anatomy of the Yellow Perch rca *Favescens*).

) MEYER (Select), *New York City.* On India Rubber.

CK PLUMB MILES (Chemistry), *Salisbury.* On the Causes of Different alities of Cast Iron.

ALLEN MILLER (Civil Engineering), *New Haven.* Discussion of the Curves ose Equation is $\sin^4 x + \sin^4 y = a \sin x \sin y \sin \frac{x+y}{2}$.

A MAYO NEWHALL (Select), *San Francisco, Cal.* On Mormonism in the st, the Present and the Future.

ROBERT PADDOCK (Natural History), *Cheshire.* On the Anatomy of the een Frog (*Rana Clamitans*).

M BEACH PALMER (Civil Engineering), *Bridgeport.* A Review of the Iron ht House, South West Pass, La.

RD LARNED RYERSON (Select), *Chicago, Ill.* On the Post Office of the ited States.

M BABCOCK SAWYER (Select), *Buffalo, N. Y.* On Fairy Mythology as Illus- ted in the Elizabethan Writers.

S DAVID SEEBERGER (Select), *Chicago, Ill.* On the United States Bank 1816.

V GILBERT SHEAK (Select), *Binghamton, N. Y.* On Usury.

EDWARD SHERMAN (Select), *Morristown, N. J.* On Cuneiform Inscrip- ns; their Discovery, Interpretation, and Historical Value.

S EWING SHERMAN, B.A., Georgetown College (Select), *St. Louis, Mo.* On emical Evidence in Cases of Arsenic Poisoning.

WATSON SMITH (Select), *Chicago, Ill.* On Trades Unions and Strikes.

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FRANCIS AUGUSTUS TERRY (Chemistry), *Lyme.* On the Origin of Magnetic Sands in the Vicinity of New Haven.

FREDERICK WILLIAM VANDERBILT (Select), *New York City.* On the Poor Laws of England.

CHARLES WILLIAM VAN VLECK (Select), *Cincinnati, O.* On the Union Pacific Railroad.

CHARLES ALEXANDER WATSON (Select), *Hartford.* On Direct Taxation in the Fiscal History of the United States.

FREDERICK WOOD (Civil Engineering), *Norwalk.* On Pile Foundations.

THOMAS YEATMAN (Select), *New Haven.* On the Indian Policy of the United States Government.

PRIZES.

The following prizes announced at the anniversary:

CLASS OF 1876.

For excellence in English Literature, the prize awarded to THOMAS E. SHERMAN, *St. Louis, Mo.*

For excellence in German, the prize awarded to MAX MAILHOUSE, *New Haven.*

For excellence in French, the prize awarded to FREDERICK P. DEWEY, *West Haven.*

For excellence in Civil Engineering, the prize awarded to PORTER D. FORD, *Washington.*

CLASS OF 1877.

For excellence in the Mathematics of Junior Year, the prize awarded to JOSEPH P. IDDINGS, *Orange, N. J.*, with honorable mention of JOHN E. BUDDINGTON, *Huntington.*

For excellence in Chemistry, the prize awarded to HORACE L. WELLS, *New Britain.*

For excellence in Mineralogy, the prize awarded to SAMUEL L. PENFIELD, *Catskill, N. Y.*

CLASS OF 1878.

For excellence in all the Studies of Freshman Year, the prize awarded to LEVI A. ELIEL, *Chicago, Ill.*, with honorable mention of JOHN P. BARTLETT, *New Britain.*

For excellence in German, the prize awarded to RALPH A. HARMAN, *Cleveland, O.*

For excellence in Mathematics, the prize awarded to WALTER L. COWLES, *Wallingford.*

For excellence in Physics, the prize awarded to CHARLES S. CHURCHILL, *New Haven.*

For excellence in Mechanical Drawing, the prize awarded to JOHN L. BLACKMORE, *City of Mexico, Mexico.*

The anniversary exercises for the Class of 1877 were held on Tuesday, June 26th, 1877, at which time ten theses, denoted in the following schedule by an asterisk, were publicly read. The following are the names of the candidates for degrees, with the subjects of their theses.

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CIVIL ENGINEERS. (3)

3 JAMES MORSE, Ph.B., Engineer Massilon Iron Bridge Co., *Massilon, O.* ign of a Wrought Iron Truss Bridge of 210 feet span, built by the Com- y across Mahonning river at Warren, Ohio.

1 LUCIEN SCAIFE, Ph.B., *Pittsburgh, Pa.* Improvement of the Upper ıe and Yonne Rivers, France.

DYNAMIC ENGINEERS. (2)

3 HOWARD FITCH, Ph.B., *New Haven.* Design of a Machine for Cutting ist Drills.

3 HILDEBRAND, Ph.B., *New Haven.* Design of an Iron Steam Ship of ee Thousand Five Hundred Tons Displacement.

BACHELORS OF PHILOSOPHY. (52)

1 WHITTLESEY ABBOTT (Select), *Yarmouth, Me.* On the Rocky Mountains Colorado.

1 HENRY BACKUS (Civil Engineering), *Cleveland, O.* On the Ashtabula dge and the Causes of its Failure.

HENRY BARTLETT (Civil Engineering), *North Guilford.* On the Roof ss of the Car Shop of the N. Y., N. H., & H. R. R.

3 BURKE BELKNAP (Dynamic Engineering), *Louisville, Ky.* On Sanitary ıinage.

D BERENS (Select), *Philadelphia, Pa.* On the Strikes in the Mining Dis- ts of Pennsylvania.

LEWIS BETTS (Civil Engineering), *Norwalk.* On the Iron Bowstring der Bridge at Westville.

LEWIS BIDWELL (Civil Engineering), *Kansas City, Mo.* On the Kansas y Bridge.

HENRY BREWSTER (Select), *New Haven.* On the Occupation and Culti- ion of the Soil in Village Communities.

EDWARDS BUDDINGTON (Civil Engineering), *Huntington.* Review of the ot Bridge over the Housatonic, on the N. Y., N. H., & H. R. R.

CALDWELL (Medical), *Carthage, O.* On the Anatomy of the American licinal Leech (*Macrobdella decora*)

1 GILBERT CALHOUN (Select), *Hartford.* On the Arthurian Legend and History in English Literature.

ICK LEONARD COWLES (Select), *New Haven.* On the Growth and Progress Agriculture in the United States.

HOLBROOK CURTIS (Medical), *New York City.* On the Encephalon of the d (*Alosa sapidissima*).

AMOS DOOLITTLE (Civil Engineering), *Cheshire.* On the Shore Line R. R. dge over the Quinnipiac River at Fair Haven.

ICE BRUCE FENN (Civil Engineering), *New Haven.* On the South-West lge Light House.

ELLOGG FIELD (Civil Engineering), *Germantown, Pa.* On the Lake Roland n, Baltimore Co., Md.

1 JOHN FRANCKE (Select), *New York City.* On Turkey and the Turks.

1 EDGAR GARD (Chemistry), *New York City.* On the Combination of bon with Nickel.

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ELISHA MORPETH HALL (Select), *Brooklyn, N. Y.* On Coinage.
M STANLEY HINE (Civil Engineering), *Bridgeport.* On the Springfield Gas achine.
R HOLCOMB (Civil Engineering), *New Hartford.* The Law and its Appli-tion in regard to unsafe Engineering Constructions.
E COBB HOWARD (Select), *Townshend, Vt.* On Serfdom in Russia.
H PAXSON IDDINGS (Civil Engineering), *Orange, N. J.* Review of the Pump-g Engine, Pumps, and Shaft at the Ueberroth Mine, Friedensville, Pa.
ES MAPLES JARVIS (Civil Engineering), *Binghamton, N. Y.* On the Improve-ent of New Haven Harbor.
NCE KNEELAND (Civil Engineering), *Brooklyn, N. Y.* On the Royal Gun-wder Factory at Waltham Abbey, England.
THIEN FOH LAISON (Civil Engineering), *Shanghai China.* On Underground rveying, applied to the Cheshire Barytes Mine.
COOPER LAWRANCE (Dynamic Engineering), *New York City.* On Steel, its anufacture and its Application to Structures hitherto made of Iron.
WINSLOW LEIGHTON (Civil Engineering), *New Haven.* On Railway Coaches.
ES JAMES LUCK (Civil Engineering), *Rouse's Point, N. Y.* On Fort Mont-mery at Rouse's Point, N. Y.
R JOHN MARTIN (Select), *Orange, N. J.* On Carpet Manufacture.
ES KNOX MIXTER (Select), *Rock Island, Ia.* On Woman's Wages.
BLAIR MURRAY (Select), *Norwich.* On the Jeffersonian Embargo.
L LEWIS PENFIELD (Chemistry), *Catskill, N. Y.* On Basic Sulphates of Copper.
RD NOURSE PRATT (Select), *Elmira, N. Y.* On the History of Direct Tax-on in the United States.
S RAWLINSON READ (Civil Engineering), *Hartford.* On Explosives as Ap-ied to Engineering.
WATERMAN ROBINSON (Civil Engineering), *Fair Haven.* On a Proposed an for a Wrought Iron Pin Bridge at Middletown Avenue, New Haven.
S FITCH ROWLAND (Dynamic Engineering), *Greenpoint, N. Y.* On the pplication of Steam for the Propulsion of War Vessels of the United States avy.
ALVIN SCOTT (Civil Engineering), *Naugatuck.* On the West River Bridge.
IAM THOMPSON SEDGWICK (Medical), *Farmington.* On the Functions of the ppendages, and the Anatomy of the Larger Fiddler Crab (*Gelasimus minax*).
ES DWIGHT SMITH (Dynamic Engineering), *Plantsville.* On Drop Forgings.
E SMITH (Civil Engineering), *New Haven.* On the Process and Applications the Sand Blast.
ER SNOWDON SMITH (Select), *Cincinnati, O.* On Trades Unions.
Y LING TAYLOR (Medical), *New York City.* On the Alimentary Canal of e Larval Bull-frog (*Rana Catesbiana*).
R JOHN TENNEY (Dynamic Engineering), *New Haven.* On the Drainage of ondon.
MASON THOMAS (Medical), *Wickford, R. I.* On the Circulatory System of e Common Flounder.
M GILMAN THOMPSON (Medical), *New York City.* On the Fœtal Circulatory stem of the Domestic Pig.
BEEL WEEKES (Select), *New York City.* On the Paper Money of the Amer-n Revolution.

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*Honor. LEMUEL WELLS (Chemistry), *New Britain.* Determination of Titanic l in Iron Ores containing Phosphoric Acid.

ARNOLD WICKERSHAM (Select), *Lancaster, Pa.* On the Advantages derived ociety from the Use of Money.

DANIEL WILSON (Civil Engineering), *Newburg, N. Y.* Comparison of the of a Bridge over the Hudson River at Poughkeepsie, N. Y., and that of nnel under the River.

LEVERETT WILSON (Civil Engineering), *West Killingly.* On the Low Ser- Pumping Engine of the Providence Water Works.

YOUNG (Select), *Honesdale, Pa.* On the Application of the Principle of ural Selection to the Origin and Development of Nations.

PRIZES.

following prizes were announced at this anniversary:

CLASS OF 1877.

ence in Geology and Zoology, the Belknap prize awarded to HENRY L. LOR, *New York City.*

ence in English Literature, the prize divided between JOSEPH G. CALHOUN, *tford*, and HORACE C. HOWARD, *Townshend, Vt.*

ence in German, the prize awarded to HENRY L. TAYLOR, *New York City.*

ence in French, the prize awarded to HENRY L. TAYLOR, *New York City.*

ence in Civil Engineering, the prize awarded to JOSEPH P. IDDINGS, *Orange,* .

CLASS OF 1878.

ence in the Mathematics of Junior Year, the prize awarded to WALTER L. LES, *Wallingford.*

ence in Chemistry, the prize divided between EDWARD E. BREWSTER, *t Cornwall*, and EDWARD H. SMITH, *Brooklyn, N. Y.*

ence in Mineralogy, the prize awarded to EDWARD E. BREWSTER, *West wall.*

CLASS OF 1879.

ence in all the Studies of Freshman Year, the prize divided between LINDON ES, *Chicago, Ill.*, and GEORGE A. SAUNDERS, *Newport, R. I.*

ence in German, the prize awarded to WILLIAM J. COMSTOCK, *Toledo, O.*

ence in Mathematics, the prize divided between LINDON BATES, *Chicago,* and GEORGE A. SAUNDERS, *Newport, R. I.*

ence in Physics, the prize divided between GEORGE A. SAUNDERS, *Newport,* , and HERBERT E. SMITH, *Hartford*, with honorable mention of ALBERT EBSTER, *Bethlehem, Pa.*

ence in Mechanical Drawing, the prize divided between ROGER C. BALLARD, *sville, Ky.*, and SAMUEL E. BARNEY, *New Haven*, with honorable mention INDON BATES, *Chicago, Ill.*

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PROGRAMME OF STU

AND

CATALOGUE,

FOR THE COLLEGE YEAR 18

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CALENDAR.

1877.		
ept.	Thursday,	First Term begins.
)ec.	Thursday,	First Term ends.
1878.		**Winter Vacation of three weeks.**
an.	Thursday,	Second Term begins.
pril,	Wednesday,	Spring Recess begins.
pril,	Wednesday,	Spring Recess ends.
une,	Tuesday,	Meeting of Appointing Board.
une,	Tuesday,	Anniversary.
une,	Thursday,	Commencement.
une,	Friday,	Examination for Admission.
une,	Saturday,	
		Summer Vacation of eleven weeks.
11 Sept.	Tues., Wedn.,	Examination for Admission.
ept.	Thursday,	First Term begins.
)ec.	Thursday,	First Term ends.

ABBREVIATIONS.

S. H.	Sheffield Hall.
N. S. H.	North Sheffield Hall.
TR.	Treasury Building.
D.	Durfee College.
F.	Farnam College.
D. H.	Divinity Hall.
W. D. H.	West Divinity Hall.
P. M.	Peabody Museum.

he buildings belonging to the Sheffield Scientific School, the rooms num- from 1 to 21 are in Sheffield Hall: from 26 to 58 in North Sheffield Hall.

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REV. NOAH PORTER, D.D., LL.D.

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REV. LEONARD BACON, D.D., LL.D., NEW HAVE
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REV. HIRAM P. ARMS, D.D., NORWICH TOWN.
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HON. WILLIAM WALTER PHELPS, M.A., NEW
MASON YOUNG, M.A., NEW YORK CITY.

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FRANKLIN B. DEXTER, M.A.

TREASURER.

HENRY C. KINGSLEY, M.A. (5 TR.) 23

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VERNING BOARD.

BY THE CORPORATION OF YALE COLLEGE.

President.

:R, D.D., LL.D., (7 TR.) 31 Hillhouse av.

Chairman and Executive Officer.

, (3 S. H.) 14 Trumbull st.

Professors.

ANGED IN THE ORDER OF THEIR GRADUATION.

ON,
(34 N. S. H.) 72 Prospect st.

N,
nomy, *Theoretical and Practical.* (39 N. S. H.) 88 Trumbull st.

NEY,
rench. (205 D.) 246 Church st.

,
(3 S. H.) 14 Trumbull st.

SON,
gricultural Chemistry. (12 S. H.) 54 Trumbull st.

VER,
TON *Professor*). (4 S. H.) 246 Orange st.

29 Eld st.

(14 N. S. H.) 70 Sachem st.

BURY,
(6 S. H.) 22 Lincoln st.

H,
(8 P. M.) 9 College st.

KER,
and History. (40 N. S. H.) 68 Whitney av.

stry and Metallurgy. (20 S. H.) 189 Temple st.

ILL,
gy. (42 N. S. H.) 148 College st.

tomy. (42 N. S. H.) 148 College st.

ER,
(8 S. H.) 25 Eld st.

eering (HIGGIN *Professor*). (45 N. S. H.) 328 Howard av.

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ADDITIONAL TO THE GOVERNING BOARI

T S. WHEELER,
rman.

BAILEY,
cution. (150 F.

H. NIEMEYER, Professor in Yale School of Fine Arts
e Hand Drawing.

RICK R. HONEY.
scriptive Geometry and Projection Drawing. (53 N. S. H

HARGER,
læontology. (9 P. M.)

H J. SKINNER,
thematics.

FIELD MERRIMAN,
il Engineering. (16 S.

ST H. EDGREN,
nch.

GE W. HAWES,
neralogy.

LL H. CHITTENDEN,
siological Chemistry. (13 S. H.)

H F. KLEIN,
chanical Drawing. (45 N. S.

AM H. PATTON,
ology.

H P. IDDINGS,
rveying.

EL L. PENFIELD,
alytical Chemistry.

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GRADUATE STUDENTS.

ım Whittlesey Abbott, PH.B.	*New Haven*	257 Church st.
e Henry Bartlett, PH.B.	*North Guilford*	157 Church st.
s Burke Belknap, PH.B.	*Louisville, Ky.*	86 W. D. H.
as Marcus Blakslee, PH.B. Madison University	*Hamilton, N. Y.*	36 Prospect st.
is Elwood Brown, PH.B.	*West Haven*	West Haven.
ll Henry Chittenden, PH.B.	*New Haven*	95 Humphrey st.
ric Henry Crafts, B.A. artmouth College	*Uncasville*	170 George st.
as Henry Dewey, LL.B.	*West Haven*	49 Church st.
n Amos Doolittle, PH.B.	*Cheshire*	17 Wooster pl.
d Livingston Ford, PH.B.	*Buffalo, N. Y.*	48 College st.
e Bird Grinnell, B.A.	*New York City*	6 Library st.
e Wesson Hawes, PH.B.	*Boston, Mass.*	14 S. H.
Allen Hazen, B.A. rtmouth College	*New Haven*	169 Temple st.
h Paxon Iddings, PH.B.	*Orange, N. J.*	119 W. D. H.
Boyd Neal, B. A.	*Bloomsburg. Pa.*	6 Library st.
rt Franklin Northrup, B.A. Middlebury College	*Shoreham, Vt.*	73 York st.
Robert Paddock, PH.B.	*Cheshire*	Cheshire.
m Hampton Patton, B.A.	*Waterbury*	46 N. S. H.
l Lewis Penfield, PH.B.	*Catskill, N. Y.*	14 S.
s Waterman Robinson, PH.B.	*Fair Haven*	464 Chapel st.
e Smith, PH.B.	*New Haven*	83 Ashmun st.
e Lemuel Wells, PH.B.	*New Britain*	N. S. H.

GRADUATES, 23.

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SENIOR CLASS.

n Day Allen	*Hartford*	1
r Landon Alvord	*West Winsted*	1
omeroy Bartlett	*New Britain*	1
uis Blackmore	*City of Mexico, Mexico*	
l Everett Brewster	*West Cornwall*	
Williams Brown	*Yonkers, N. Y.*	
n Tyler Browne	*Lisbon*	1
Lowber Burrows	*Decatur, Ill.*	
William Canfield	*Hartford*	
Williams Chapin	*Springfield, Mass.*	
n Grover Chapin	*Somers*	
Samuel Churchill	*New Haven*	25
Linsley Cowles	*Wallingford*	
us James Emery	*Bangor, Me.*	
r Farwell	*Chicago, Ill.*	
Hart Doolittle Fowler	*North Haven*	1
Zaccheus Gordon	*Brookville, Pa.*	
Granger	*Chicago, Ill.*	4
l Vassall Greene	*Norwich*	4
Sturges Guthrie	*Buffalo, N. Y.*	4
Augustus Harman	*Cleveland, O.*	
Tillman Hart	*New Haven*	8
Stewart Hegeman	*Brooklyn, N. Y.*	
Betts Hillhouse	*New Haven*	3
Samuel Hulbert	*West Winsted*	3
Mastin Jacks	*Helena, Ark.*	
eckwith Jillson	*Whitehall, N. Y.*	
l Charless LeBourgeois	*St. James Parish, La.*	
Richard Lee	*Kenosha, Wisc.*	
Webb Mason	*Orange, N. J.*	
n James Perry Moore	*New Britain*	1
Turner Moorhead	*Pittsburgh, Pa.*	
Henry Potts	*Pittstown, N. J.*	
l Townsend Reed	*Albany, N. Y.*	2
Theodore Richmond	*Johnsonville, N. Y.*	
l Kilbourn Roberts	*New Haven*	
Roorbach	*New York City*	
l Hubbard Russell	*New Haven*	1
l Herndon Smith	*Brooklyn, N. Y.*	
n Annin Vliet	*Cleveland, O.*	1
ennings Ward	*Marseilles, Ill.*	1
d Beecher Wilson	*Geneva, Ill.*	
Dana Winslow	*Washington, D. C.*	
		8

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JUNIOR CLASS.

ɔk Innis Allen	*Auburn, N. Y.*	33 Prospect st.
Vashington Asher	*New Haven*	6 Orange st.
Montgomery Atwater	*New Haven*	15 Elm st.
Ketchum Averill	*Bridgeport*	126 High st.
Rufus Ayres	*Woodmont*	8 Lock st.
el Terry Bacon	*New Haven*	196 Crown st.
Eben Barney	*New Haven*	110 Olive st.
Frederick Hunter Bartlett	*Buffalo, N. Y.*	62 W. D. H.
Bates	*Chicago, Ill.*	A.
Bidleman Bissell	*Lakeville*	111 Park st.
Booth	*South Kingston, R. I.*	17 Wooster pl.
ɔsborn Carrington	*New Haven*	527 Chapel st.
ɔk Burr Clemmons	*New Haven*	162 Putnam st.
James Comstock	*Toledo, O.*	37 College st.
William Congdon	*Brooklyn, N. Y.*	44 High st.
ɔward Cromwell	*Cranford, N. J.*	122 College st.
Thompson Dodd	*West Meriden*	134 College st.
Dodge	*Stamford*	134 College st.
Clarence Egan	*Chicago, Ill.*	36 Elm st.
ı Young Foote	*New Haven*	111 Park st.
Norton Fowler	*Agawam, Mass.*	141 Bradley st.
ırrier Gallagher	*New Haven*	21 Olive st.
n Godfrey	*Southport*	134 College st.
Ianson Harrison	*Indianapolis, Ind.*	15 Home pl.
Waldo Hart	*New Britain*	33 Prospect st.
ɔudley Hibbard	*Woodside, N. Y.*	464 Chapel st.
Iillhouse	*New Haven*	3 Hillhouse av.
DeVilliers Hoard	*Chicago, Ill.*	416 Chapel st.
Perry Hull	*Lebanon*	128 High st.
wett	*Brooklyn, N. Y.*	55 Trumbull st.
Drake Johnson	*Washington, D. C.*	A.
ɔk Augustus Jones	*Newark, N. J.*	163 Temple st.
Dennis Lɔwis	*Bridgeport*	134 College st.
Walker Meeker	*Chicago, Ill.*	55 Trumbull st.
Mitsikuri	*Tokio, Japan*	523 Chapel st.
ɔorhead	*Pittsburgh, Pa.*	109 Elm st.
Delevan Nelson	*New York City*	55 Trumbull st.
Nordhoff	*Alpine, N. J.*	145 York st.
ɔk Wallace Paramore	*St. Louis, Mo.*	36 Elm st.
Wilson Patrick	*Omaha, Nebr.*	531 Chapel st.
Eckhardt Raht	*Cleveland, Tenn.*	87 Church st.
Vilette Reynolds	*Chicago, Ill.*	109 Elm st.
Ruport Sargent	*New Haven*	132 Wooster st.
Augustus Saunders	*Newport, R. I.*	157 Bradley st.
Seth Silsby	*Seneca Falls, N. Y.*	36 Elm st.

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Rufus Henry Skeel	*Newburgh, N. Y.*	31 Prospect st.
Herbert Eugene Smith	*Hartford*	141 Bradley st.
Thaddeus Henry Spencer	*Suffield*	141 Bradley st.
Isaiah Kidder Stetson	*Bangor, Me.*	62 W. D. H.
Daniel Eddie Stone	*Cleveland, O.*	61 Grove st.
Arthur Stoddard Van Voorhis	*New York City*	94 Grove st.
John Thomas Waring	*Yonkers, N. Y.*	61 Grove st.
Albert Lowery Webster	*Bethlehem, Pa.*	119 W. D. H.
Charles Seward Wilcox	*Painesville, O.*	136 College st.
Walter Smith Williams	*Evanston, Ill.*	36 Elm st.
Charles Henry Wilmerding	*Hartford*	29 Prospect st.

JUNIORS, 56.

FRESHMAN CLASS.

Daniel Sidney Appleton	*New York City*	165 Temple st.
Charles Backus Ball	*New Britain*	113 Bailey st.
Edward Henry Ball	*Milwaukee, Wisc*	165 Temple st.
Hartman Bache Borie	*Philadelphia, Pa.*	156 York st.
Harry Banning Bradford	*Wilmington, Del.*	169 Temple st.
Charles Sumner Brown	*Fair Haven*	25 Whitney av.
Joseph Arthur Chanute	*New York City*	128 High st.
George Huntington Clark	*Norwich*	20 Prospect st.
Arthur Baylies Coffin	*Edgartown, Mass.*	191 Temple st.
Edward Allen Colby	*St. Johnsbury, Vt.*	23 Prospect st.
Frank McAlpine Collin	*Penn Yan, N. Y.*	72 High st.
Peter Franklin Conway	*New Haven*	117 Washington st.
Charles Mabie Crouse	*Syracuse, N. Y.*	120 Chapel st.
Edward Merrill Currier	*Chelsea, Mass.*	14 Lock st.
Harry Sprague Davidson	*San Francisco, Cal.*	161 Temple st.
William Loami Davis	*Chicago, Ill.*	523 Chapel st.
Thomas Edward Doolittle	*Onarga, Ill.*	113 Olive st.
Jacob Edward Emery	*Fair Haven*	73 Exchange st.
George Robert Ferguson	*New Haven*	29 Sylvan av.
William Henry Fox	*Washington, D. C.*	25 Prospect st.
George Washington Gibson	*New Haven*	44 Edwards st.
George Edward Goodspeed	*East Haddam*	183 George st.
John Warren Hardenbergh	*Jersey City, N. J.*	117 Elm st.
Samuel Higgins	*Buffalo, N. Y.*	82 Wall st.
Louis Maynard Higginson	*Newburgh, N. Y.*	161 Temple st.
Walter Hitchcock	*Cheshire*	29 Prospect st.
Theodore Lanahan Hooper	*Baltimore, Md.*	169 Temple st.
James Barland Houston	*Enfield*	163 Temple st.
Frank Allison Hubbard	*Sandusky, O.*	121 Park st.
Colin Macrae Ingersoll	*New Haven*	85 Trumbull st.
Charles Henry Johnson	*Union, N. J.*	12 Trumbull st.

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David Brown Lewis	*Utica, N. Y.*	12 Trumbull st.
Earnest Theophilus Liefeld	*New Haven*	36 Orchard st.
Richard Becker Lyon	*New Haven*	710 Chapel st.
Willey Sollon McCrea	*Chicago, Ill.*	221 Elm st.
Edwin Kirtland Morse	*Poland, O.*	29 College st.
Carl Eugene Munger	*Watertown*	23 Prospect st.
Edward Butler Needham	*Hartford*	191 Temple st.
Frederic Adriance Osborn	*New Haven*	150 York st.
John Irving Pearce	*Chicago, Ill.*	71 York st.
George Benjamin Phelps	*Watertown, N. Y.*	84 Wall st.
Dwight Porter	*Hartford*	14 Lock st.
Edgar Sheffield Porter	*New Haven*	38 Hillhouse av.
Edward Freeman Porter	*Stowe, Vt.*	23 Prospect st.
Joel Howard Reed	*Albany, N. Y.*	251 Church st.
Edwin McNeil Rogers	*Central City, Col.*	191 Temple st.
George Bliss Rogers	*Lexington, Mass.*	169 Temple st.
Isaac Marion Rosenthal	*Rochester, N. Y.*	35 Howe st.
William Bartlett Schofield	*West Point, N. Y.*	48 College st.
Henry Starkweather	*New Haven*	170 Martin st.
Elliott Joseph Stoddard	*Seymour*	80 Broadway
Schuyler Van Vechten	*Albany, N. Y.*	165 Temple st.
Adrian Rowe Wadsworth	*Farmington*	135 St. John st.
William Candee Warren	*Buffalo, N. Y.*	82 Wall st.
Adolph Frederic Wehner	*New Haven*	544 Chapel st.
George Goodman Williams	*Glastonbury*	133 College st.
Arthur Burnham Woodford	*West Winsted*	36 York sq.
William Henry Yale	*New York City*	201 Orange st.

FRESHMEN, 58

SPECIAL STUDENTS NOT CANDIDATES FOR A DEGREE.

Louis Norton Bail	*New Haven*	43 Park st.
Thomas Attwater Bostwick	*New Haven*	162 Olive st.
William Thomas Cochrane	*Durham, Ontario*	119 Greene st.
Caldwell Hart Colt	*Hartford*	165 Temple st.
Alfred Daggett	*New Haven*	9 Warren st.
Arthur Melancthon Diggles	*Tarrytown, N. Y.*	55 Trumbull st.
Joseph Caldwell Earle	*New Haven*	214 Orchard st.
Robert Haggert	*Brompton, Ontario*	119 Greene st.
Charles Wilbur Nichols	*Bridgeport*	Bridgeport
Edward H. Phipps	*New Haven*	144 Chapel st.
Benjamin Silliman Warner	*Pomfret*	34 Hillhouse av.
Walter Watson	*Northampton, Mass.*	90 Grove st.
Charles Wilson Whittlesey	*New Haven*	524 Chapel st.
Eugene Benjamin Wilson	*Elizabeth, N. J.*	147 York st.

SPECIAL STUDENTS, 14.

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SHEFFIELD SCIENTIFIC SCHOOL.

I.

OBJECTS.

e Sheffield Scientific School is devoted to instruction esearches in the mathematical, physical, and natural sciences, reference to the promotion and diffusion of science, and also e preparation of young men for such pursuits as require al proficiency in these departments of learning. It is one of epartments of Yale College, like the law, medical, theologi- nd art schools, having its separate funds, buildings, teachers, egulations, but governed by the Corporation of Yale Col- which appoints the professors and confers the degrees. It part, analogous to the academic department or classical e, and, in part, to the professional schools.

e instruction is intended for two classes of students:—

Graduates of this or of other Colleges, and other persons ied for advanced or special scientific study.

Undergraduates who desire a training chiefly mathematical cientific, in less part linguistic and literary, for higher scien- tudies, or for various other occupations to which such ng is suited.

II.

HISTORY AND ORGANIZATION.

e School was commenced in 1847. In 1860, a convenient ng and a considerable endowment were given by Joseph E. eld, Esq., of New Haven, whose name, at the repeated st of the Corporation of Yale College, was afterward ned to the foundation. Mr. Sheffield has since frequently nunificently increased his original gifts.

1864, by an act of the Connecticut Legislature, the national for the promotion of scientific education (under the con- onal enactment of July, 1862) was given to this department le College, which thus became "the College of Agriculture he Mechanic Arts for Connecticut." Since that time, and ally since the autumn of 1869, numerous liberal gifts have

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been received from the citizens of New Haven, and from other gentlemen in Connecticut, New York, and St. Louis, for the endowment of the School, and the increase of its collections.

The action of the State led to the designation by law of a State Board of Visitors, consisting of the Governor, Lieutenant-Governor, three senior Senators, and the Secretary of the State Board of Education; and this Board, with the Secretary of the Scientific School, is also the Board for the appointment of students to hold the State scholarships.

At the request of the Governing Board, the Corporation of Yale College has also appointed a Board of Councillors for the School, consisting of a number of gentlemen who have taken a deep interest in its welfare.

The Governing Board consists of the President of Yale College and the Professors who are permanently attached to the School. There are several other instructors associated with them, a part of whom are connected with other departments of the College.

III.

BUILDING AND APPARATUS.

The two buildings in which the work of instruction in the Scientific School is mainly carried on are called Sheffield Hall and North Sheffield Hall; but instruction in Mineralogy, Geology, and Biology, including Zoology and Comparative Anatomy, is now given entirely in the Peabody Museum. These halls contain a large number of recitation and lecture rooms, a hall for public assemblies and lectures, chemical and metallurgical laboratories, a photographical room, an astronomical observatory, museums, a library and reading room, besides studies for some of the professors, where their private technical libraries are kept.

The following is a summary statement of the collections belonging to the School:

1. Laboratories and Apparatus in Chemistry, Metallurgy, Physics, Photography, and Zoölogy.
2. Metallurgical Museum of Ores, Furnace Products, etc.
3. Agricultural Museum of Soils, Fertilizers, useful and injurious insects, etc.
4. Collections in Zoölogy.
5. Astronomical Observatory, with an equatorial telescope by Clark and Sons of Cambridge, a meridian circle, etc.
6. A Collection of Mechanical Apparatus, constituting the "Collier Cabinet."

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7. Models in Architecture, Geometrical Drawing. Civil Engineering, Topographical Engineering, and Mechanics; diagrams adapted to public lectures; instruments for field practice.
8. Maps and Charts, topographical, hydrographical, geological, etc.

The herbarium of Professor Brewer, and the astronomical instruments of Professor Lyman, are deposited in the buildings. Professor Eaton's herbarium, near at hand, is freely accessible. Students also have access to the various laboratories and collections in Natural Science in the Peabody Museum.

Students are also admitted, under varying conditions, to the College and Society libraries, the College Reading Room, the School of the Fine Arts, and the Gymnasium.

IV.

THE LIBRARY.

The special technical library of the Scientific School consists of about five thousand volumes. Included in this is the "Hillhouse Mathematical Library" of twenty-four hundred volumes, collected during a long series of years by Dr. William Hillhouse, and in 1870 purchased and presented to the Institution by Mr. Sheffield. A catalogue of this collection forms a supplement to the Annual Report of the Governing Board for 1870. All the prominent scientific journals of this country and of Europe, together with the proceedings of foreign academies, and of scientific societies, can be found either in this library or in the College Library to which students have access.

V.

INSTRUCTION FOR GRADUATE AND SPECIAL STUDENTS.

Persons who have gone through undergraduate courses of study, here or elsewhere, may avail themselves of the facilities of the School for more special professional training in the physical sciences and their applications, gaining in one, two, or three years the degree of BACHELOR OF PHILOSOPHY, or, in two additional years of Engineering study, that of CIVIL ENGINEER, or of DYNAMIC ENGINEER.

Or, engaging in studies of a less exclusively technical character, they may become candidates for the degree of DOCTOR OF PHILOSOPHY. The instruction in such cases will be adapted to the particular needs and capacities of each student, and may be combined with that given by the graduate instructors in other departments

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of the University. This degree is conferred upon those who, having already taken a Bachelor's degree, engage as students in the Department of Philosophy and the Arts for not less than two years in assiduous and successful study. It is not given upon examination to those whose studies are pursued elsewhere. The requirements for it will in some cases exact of the student more than two years of post-graduate labor; so, especially, wherever the course of undergraduate study has been, as in the Scientific School, of less than four years. The candidate must pass a satisfactory final examination, and present a thesis giving evidence of high attainment in the branches of knowledge to which he has attended. A good knowledge of Latin, German and French will be required in all cases, unless, for some exceptional reason, the candidate be excused by the Faculty. The graduating fee is ten dollars.

Subjects likely to receive special attention are suggested as follows:—

Professor NORTON will instruct in applied mechanics and in spherical astronomy.

Professor LYMAN, in the use of meridional and other astronomical instruments, and in astronomical spectroscopy.

Professor DUBOIS, in the principles of thermodynamics, and utilization of heat as a source of power.

Professor BRUSH, in the analysis and determination of mineral species, and in descriptive mineralogy.

Professor JOHNSON, in theoretical, analytical, and agricultural chemistry.

Professor BREWER, in agriculture and forest culture, in the use of the microscope, and in physical geography.

Professor CLARK, in definite integrals, differential equations, analytical mechanics, the theory of numerical approximations, and the method of least squares.

Professor EATON, in structural and systematic botany, including the North American flora and the description of genera and species.

Professor MARSH, in palæontology and comparative osteology.

Professor WALKER, in public finance and in the statistics of industry.

Professor ALLEN, in analytical chemistry, and in metallurgy.

Professor VERRILL, and Professor SMITH, in zoölogy and geology.

The same courses of study are open, for a longer or shorter time,

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to graduate students who do not desire to become candidates for a degree.

Students who have taken the degree of Bachelor of Philosophy, may obtain the degree of CIVIL or of DYNAMIC ENGINEER at the end of two academical years, by pursuing the following higher course of study and professional training.

The course of study for the degree of CIVIL ENGINEER will comprise—

1. Higher Calculus. Higher Geometry. Theory of Numerical Operations.
2. Analytical Mechanics. Mechanics applied to Engineering.
3. A Course of Construction and Design. Projects.
4. Practical Astronomy, with use of instruments, computations, etc.

This course will occupy one year.

To secure the requisite amount of professional knowledge and practice, the candidate will be required to furnish a comprehensive report of the results of an examination into the existing condition of some special line of constructive art; or to present proper evidence that he has had actual charge in the field, for several months, of construction or surveying parties, or held some responsible position deemed equivalent to this.

An elaborate design must also be submitted of some projected work of construction, based upon exact data obtained from careful surveys made by the candidate, and comprising all the requisite calculations, and the necessary detailed drawings, and accompanied by full specifications of the work to be done, and the requirements to be met by the contractor.

The fee for this degree is five dollars.

The course of study for the degree of DYNAMIC ENGINEER will comprise

1. Higher Calculus, General Theory of Equations and of Numerical Operations.
2. General Principles of Dynamics (Analytical Mechanics.) Including special application of these principles to Dynamical problems.
3. Construction of Machines. Designs.
4. Preparation of theses on special subjects in Dynamic Engineering.

During the second year candidates will be permitted to employ such a portion of their time as may be deemed advisable or necessary in the examination of engineering works and manufacturing establishments, and may also have the privilege of entering upon professional practice, provided it is done with the knowledge and consent of the Professor of Dynamic Engineering, and under such circumstances as shall appear to him to be favorable to professional progress.

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An elaborate thesis on some professional subject, with an original design, or project, accompanied by proper working drawings, will be required at the end of the second year.

The fee for this degree is five dollars.

SPECIAL STUDENTS.—For the benefit of those who, being fully qualified, desire to pursue particular studies without reference to the obtaining of a degree, special or irregular students are received in most of the departments of the School; not, however, in the Select Course or in the Freshman Class.

It should be distinctly understood that these opportunities are not offered to persons who are incompetent to go on with regular courses, but are designed to aid those who, having received a sufficient preliminary education elsewhere, desire to increase their proficiency in special branches.

VI.

REQUIREMENTS FOR ADMISSION AND COURSES OF INSTRUCTION FOR UNDERGRADUATE STUDENTS.

TERMS OF ADMISSION.—Candidates must be not less than fifteen years of age, and must bring satisfactory testimonials of moral character from their former instructors or other responsible persons.

For admission to the Freshman Class the student must pass a thorough examination in the following subjects:

English Grammar—including spelling and composition.
History of the United States.
Geography.
Latin—Six books of Cæsar's commentaries or their equivalent, and simple exercises in prose composition.

Algebra—So much as is contained in Loomis's Treatise, up to the general theory of equations.

Geometry—Plane, solid, and spherical; including fundamental notions of symmetry and examples of Loci and of Maxima and Minima of Plane Figures:—an equivalent to the nine books of Chauvenet's Treatise, or to the ten books of Loomis's Elements and the Appendix, up to the section on Transversals.

Trigonometry—including the analytical theory of the trigonometrical functions and the usual formulæ; the construction and use of trigonometrical tables; and the solution of plane triangles;—so much, for example, as is contained in Wheeler's Plane Trigonometry, Boston, 1877.

In his preparation in GEOMETRY the candidate should, as far as practicable, have suitable exercises in proving simple theorems and solving simple problems

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t. It is important, too, that he should be accustomed to the numerical
n of geometric principles, and especially to the prompt recollection and
elementary formulæ of mensuration. In TRIGONOMETRY he should be
in applying the usual formulæ to a variety of simple reductions and
ations, including the solution of trigonometrical equations. Among other
odhunter's "Trigonometry for Beginners" will furnish the judicious
uch material for this class of exercises. Readiness and accuracy in
trical calculations are also of prime importance to the candidate. If the
arithms is postponed in his preparation till Trigonometry is taken up
by no means necessary or advisable), he should then have abundant
s of them to all forms of calculation occurring in ordinary practice, as
those appearing in the solution of triangles. Finally, in all of his cal-
he should study the art of neat, orderly, and readily intelligible arrange-

N, in order to assure the attainment of the required proficiency, the
hould have such continued training in parsing as shall make him
familiar with declensions and conjugations, and accurate and ready in
ation of the rules of syntax. As an additional guarantee of the proper
f these grammatical elements, the requirement has been adopted of
xercises in prose composition." By this is meant, merely, such a course
tary exercies in translation, orally and in writing, from English into Latin
nection with the systematic parsing just mentioned, shall necessitate a
with grammatical forms and the leading principles of syntax, and thus
reading of the six books of Cæsar (or their equivalent) more thorough
il. Since this course of elementary exercises in translation is designed
ration for reading, and not as a sequel to it, it should be invariably be-
e earliest stage of the study of Latin. To avoid any misapprehension
ure or the extent of the requirement, the following works are specifically
hong which the candidate for examination may make his own selection.
Harkness' "Introduction to Latin Composition," 112 pages; Leighton's
ssons," 91 pages; Smith's "Principia Latina," Part I.; or McClintock's
tin Book," 83 lessons (193 pp.). Any equivalent of these may be offered
many useful books of a similar character. A knowledge of Prosody is
ed.

LISH, Whitney's Essentials of English Grammar (Ginn and Heath, Bos-
ommended for the examination of 1878; in the examination of 1879 it
quired.

uirement in Physics, previously existing, is discontinued for the present,
ook recommended having been withdrawn by the publishers.

examinations for admission take place at North Sheffield
Friday and Saturday, June 28, 29; and on Tuesday and
day, September 10, 11, 1878. Opportunities for private
tion may, in exceptional cases, be given at other times.
78 an examination will also be held in Chicago (beginning
ay, June 28, at 9 A. M.), at a place to be announced in the
newspapers of the day previous.

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Candidates for advanced standing in the undergraduate classes are examined, in addition to the preparatory studies, in those already pursued by the class they wish to enter. No one can be admitted as a candidate for a degree, later than at the beginning of the Senior year.

THE COURSES OF INSTRUCTION, occupying three years, are arranged to suit the requirements of various classes of students. The first year's work is the same for all; during the last two years the instruction is chiefly arranged in special courses.

The special courses most distinctly marked out are the following:—

(*a.*) In Chemistry;
(*b.*) In Civil Engineering;
(*c.*) In Dynamic (or Mechanical) Engineering;
(*d.*) In Agriculture;
(*e.*) In Natural History;
(*f.*) In Biology preparatory to Medical Studies;
(*g.*) In studies preparatory to Mining and Metallurgy;
(*h.*) In Select studies preparatory to other higher studies.

The arrangement of the studies is indicated in the annexed scheme.

FRESHMAN YEAR—INTRODUCTORY TO ALL THE COURSES.

FIRST TERM—*German*—Whitney's Grammar and Reader. *English*—Hadley's Brief History of the English Language; Exercises in Composition. *Mathematics*—Plane Analytical Geometry. *Physics*—Atkinson's Ganot, with experimental lectures. *Chemistry*—Eliot and Storer's Manual; Laboratory practice. *Elementary Drawing*—Practical Lessons in the Art School.

SECOND TERM—*Language, Physics, Chemistry, and Drawing*—as stated above. *Mathematics*—Elements of the Theory of Numerical Approximations; Solution of Higher Numerical Equations; Methods of Interpolation; Analytical Geometry in Space; Spherical Trigonometry. *Physical Geography*—Lectures. *Botany*—Gray's Lessons, with Lectures. *Political Economy*—Elementary Lectures. *Drawing*—Orthographic Projection.

For the Junior and Senior years the students select for themselves one of the following courses:—

(a.) IN CHEMISTRY.

JUNIOR YEAR:

FIRST TERM—*Theoretical and Organic Chemistry*—Lectures. *Qualitative Analysis*—Fresenius. *Laboratory Practice. Blowpipe Analysis. German. French.*

SECOND TERM—*Laboratory Practice*—Quantitative Analysis. *Mineralogy*—Blowpipe Analysis and Determination of Species. Lectures. *French. German.*

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SENIOR YEAR:

TERM—*Laboratory Practice*—Volumetric and Organic Analysis. *Geology* s. *Zoology*—Lectures and Excursions. *French.*

D TERM—*Laboratory Practice*—Mineral Analysis and Assaying. *Agri-Chemistry* — Recitations and Lectures (optional). *Geology* — Dana's *Metallurgy* (optional). *Mineralogy* (optional). *French. Zoology*—

(b.) IN CIVIL ENGINEERING.

JUNIOR YEAR:

TERM—*Mathematics*—Differential and Integral Calculus. Descriptive y. *Surveying*—Field Operations. *Drawing*—Binns' Orthographic Pro- *German. French.*

D TERM—*Mathematics*—Integral Calculus. Rational Mechanics. De- Geometry. *Drawing*—Projection of Shadows and Perspective. Topo- l. Warped Surfaces. *Surveying*—Topographical. *German. French.*

SENIOR YEAR:

TERM—*Field Engineering*—Laying out Curves. Location of line of Rail- th calculations of Excavation and Embankment. Hencks' Field Book for Engineers. *Civil Engineering*—Stone Cutting—with graphical problems. Civil Engineering. *Geology*—Dana's. *Mineralogy*—Blowpipe Analysis rminative Mineralogy. *French.*

D TERM—*Civil Engineering*—Resistance of Materials. Bridges and Roofs. Materials. Stability of Arches and Walls. *Dynamics*—Principles of sm. Steam Engine. *Hydraulics*—Hydraulics and Hydraulic Motors. —Graphical Statics. *Astronomy*—Loomis's Astronomy, with practical s. *Mineralogy*—continued. *Geology*—Dynamic. *French.*

(c.) IN DYNAMIC ENGINEERING.

JUNIOR YEAR:

TERM—Differential and Integral Calculus. Descriptive Geometry. The he Level, Theodolite, and Transit. Instrumental Drawing. *German.*

D TERM—Integral Calculus. Rational Mechanics. Instrumental Draw- neral Theory of Motion, and Principles of Mechanism. *German. French.*

SENIOR YEAR:

TERM—Principles of Mechanism. Applications of the Principles of cs to Machinery. Machine Construction. Blowpipe Analysis. Resist- Materials. Construction of roof trusses, girders, and iron bridges. Drawing. *Geology. French.*

D TERM—General principles of Heat employed as a source of power. struction of Steam Generators. Steam Engines. Hot Air Engines. Engines. Water Wheels. The Construction of Water Reservoirs, and Measurement of Water Supply. Discharge of Pipes, etc. Graphical Machine Designing. *Metallurgy. Geology.*

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(d.) IN AGRICULTURE.

JUNIOR YEAR:

FIRST TERM—*Theoretical and Organic Chemistry*—Lectures. *Qualitative Analysis*—Fresenius. *Laboratory Practice. Blowpipe Analysis. German. French.*

SECOND TERM — *Laboratory Practice*—Quantitative Analysis. *Mineralogy*—Blowpipe Analysis and Determination of Species. *Physical Geography*—Lectures *Botany*—Lectures. *French. German.*

SENIOR YEAR.

FIRST TERM—*Agriculture*—Cultivation of the Staple Crops of the Northern States. Tree Planting and Forestry. *Agricultural Chemistry*—Johnson's. *Physiology*—Huxley's. *Geology*—Dana's. *Zoology. English. French.*

SECOND TERM—*Agriculture*—Laws of Heredity and Principles of Breeding. Lectures. *Geology*—Dana's. *Rural Economy*—History of Agriculture and Sketches of Husbandry in Foreign Countries. Systems of Husbandry. *Agricultural Chemistry*—Johnson's. *Geology*—Dana's. *Zoology. Botany. Microscopy. English. French.*

(e.) IN NATURAL HISTORY.

(Either Geology, Mineralogy, Zoology, or Botany, may be made the principal study, some attention in each case being directed to the other three branches of Natural History.)

JUNIOR YEAR:

FIRST TERM—*Chemistry*—Qualitative Analysis. Laboratory Practice. Recitations. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *Botany*—Gray's Manual; Use of the Microscope. *German. French.*

SECOND TERM—*Zoology*—Laboratory Practice. Excursions (land and marine). *Botany*—Laboratory Practice. Thomé's Text-book. Excursions. *Mineralogy*—continued. *Physical Geography. German. French.*

SENIOR YEAR:

FIRST TERM—*Geology*—Dana's. Excursions. *Zoology*—Laboratory Practice. Lectures. Excursions. *Botany*—Herbarium Studies. Excursions. *Physiology*—Huxley. *Linguistics*—Whitney's Life and Growth of Language. *French.*

SECOND TERM—*Geology*—Dana's. *Anatomy of Vertebrates*—Huxley's. *Zoology* Laboratory Practice. Lectures. *Botany*—Herbarium Studies, especially in the Cryptogamous Orders. Botanical Literature. Essays in Descriptive Botany. *Meteorology. French.*

Besides the regular courses of recitation and lectures on structural and systematic Zoology and Botany, and on special subjects, students are taught to prepare, arrange, and identify collections, to make dissections, to pursue original investigations, and to describe genera and species in the language of science. For these purposes, large collections in Zoology and Palæontology belonging to the College are available, as are also the private botanical collections of Professor Eaton.

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(f.) IN BIOLOGY—PREPARATORY TO MEDICAL STUDIES.

During the Junior year, the work of this course is chiefly under the direction of the instructors in Chemistry. Especial attention is given to qualitative and quantitative analysis, in their physiological and medical bearings; and to the preparation and study of the organic proximate elements. In Toxicology the organic and mineral poisons are carefully studied. The special studies of the Senior year are wholly biological, particular attention being paid to the elements of comparative anatomy, histology, and physiology, to structural and physiological botany, and to systematic zoology. Instruction is also given in embryology, the laws of heredity, and human parasites. The order of studies is as follows:

JUNIOR YEAR:

FIRST TERM—*Chemistry*—Qualitative Analysis—Fresenius'. Laboratory Practice. Recitations. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *German. French.*

SECOND TERM—*Physiological Chemistry*—Klein's Handbook. *Toxicology*—Fresenius'. Laboratory practice. Recitations. Lectures. *Botany*—Lectures, Practical Exercises in Phenogamous Plants, and Excursions. *Mineralogy*—continued. *German. French.*

SENIOR YEAR:

FIRST TERM—*Comparative Anatomy and Histology*—Laboratory Practice. *Physiology*—Huxley's, with Practical Exercises. *Botany*—Practical Exercises. Lectures, and Excursions. *Geology*—Dana's Manual. *Zoology*—Lectures and Excursions. *French.*

SECOND TERM—*Comparative Anatomy and Histology*—Laboratory Practice and Recitations. *Botany*—Lectures. Laboratory Practice in Cryptogamia, etc. *Geology*—Dana's Manual. *Zoology*—Lectures. *Laws of Heredity and Principles of Breeding*—Lectures. *French.*

(g.) IN STUDIES PREPARATORY TO MINING AND METALLURGY.

Young men desiring to become Mining Engineers, can pursue the regular course in Civil or Mechanical Engineering, and at its close can spend a fourth year in the study of metallurgical chemistry, mineralogy, etc.

(h.) IN THE SELECT STUDIES PREPARATORY TO OTHER HIGHER STUDIES.

JUNIOR YEAR:

FIRST TERM—*Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *Astronomy. English*—Early English. *History*—Freeman's Outlines. *French. German.*

SECOND TERM—*Mineralogy*—Lectures. *Physical Geography*—Guyot. Lectures. *Botany*—Lectures and Excursions and Laboratory Practice. *English*—Chaucer, Shakespeare. *History*—Freeman's Outlines, with Lectures. *Political Economy*—Rogers's Manual. *German. French.*

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SENIOR YEAR:

FIRST TERM—*Geology*—Recitations and Excursions. *Zoology*—Lectures and Excursions. *Linguistics*—Whitney's Life and Growth of Language. *English*—Shakespeare. *History*—Constitutional History of the United States. Lectures. *Political Economy*—Lectures. *French.*

SECOND TERM—*Geology and Zoology*—continued. *Meteorology*—Lectures. *Political Economy*—Lectures. *English*—Shakespeare, Milton, Dryden, Pope. *History*—Political History of the United States. History of Europe since 1848. Lectures. *French.*

Exercises in English Composition are required during the entire course from all the students. The preparation of graduating theses is among the duties of the Senior Year.

Lectures on Military Science and Tactics are annually given.

DRAWING.—The course in drawing extends through the three years. During the first term of Freshman year, the students practice free-hand drawing at the Art School building, under the direction of Professor Niemeyer, of the Yale School of the Fine Arts. After the completion of the course in free-hand drawing, instruction is given by Mr. F. R. Honey, during the second term, in the elementary principles of instrumental drawing, embracing the whole of Binn's first course of orthographic projections, and Descriptive Geometry as far as warped surfaces. This course is obligatory upon all.

During the Junior and Senior years, instruction in drawing is obligatory only on the students in Civil and Mechanical Engineering. In the former year the system of instruction embraces Binn's second course in orthographic projections, isometric drawing, shades and shadows, tinting, perspective, and warped surfaces. By this method all the problems in Descriptive Geometry are required to be worked out on the drawing-board instead of the black-board. The course extends through the entire year, and is under the direction of Mr. Honey.

In Senior year, students are required to apply the principles of drawing already obtained to works of construction, under the general supervision of the Professors of Civil and of Dynamic Engineering.

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VII.

METHODS OF INSTRUCTION.

The instructions of this institution are given chiefly in small class rooms, recitations or familiar lectures, illustrated by the apparatus at the command of the various teachers. In many studies weekly excursions are made for the purpose of collecting specimens and examining natural phenomena.

In Chemistry and Metallurgy the students work several hours daily in well-appointed laboratories, under the direct superintendence of the instructors, and are guided through systematic courses of quantitative and qualitative analysis, assaying, and the blow-pipe determination of minerals and ores.

In Botany, during the summer of Junior year, exercises in analyzing and identifying plants occur two or three times a week, followed by practice in writing characters and descriptions of plants from living specimens. Students are shown also the best methods of collecting and preserving for future study, specimens of Flowering Plants, Ferns, Mosses, Algæ, etc. In the autumn term of Senior year the work of the summer is continued. Students are encouraged to pursue special lines of Botanical investigation, and varied assistance is rendered them according to their needs. The final examination is intended to show what they have learned, and the collections they have made are considered to be of minor importance.

In Zoology weekly excursions are made during the third term of Junior and first term of Senior year, in company with the instructors, for the purpose of observing the habits and making collections of Marine, fresh-water, and terrestrial animals of all classes. Each student is required to prepare and present for examination a collection containing a specified number of species, and illustrating the various classes of animals. He must also be able to pass an examination upon his collection, at least to the extent of explaining the classes and orders illustrated, and showing why particular specimens belong to the respective classes.

In Geology excursions are made for the purpose of examining geological phenomena and making special collections of rocks and minerals. Each student is required to pass a satisfactory examination on his collections at the end of the first term of Senior year.

In addition to the above, a course of lectures is given every winter by the professors of the school and others, on topics of popular interest.

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VIII.

TUITION CHARGES.

The charge for tuition is $150 per year, payable, $55 at the beginning of the first and of the second term, and $40 at the beginning of the third term. The special student of Chemistry has an additional charge of $70 per annum for chemicals and use of apparatus. He also supplies himself at his own expense with gas, flasks, crucibles, etc., the cost of which should not exceed $10 per term. A fee of $5 is charged members of the Freshman Class for chemicals and materials used in their laboratory practice, and the same fee is required from all who take the practical exercises in Blow-pipe Analysis and Determinative Mineralogy. A fee of $5 a term will also be charged to the students in the Zoological Laboratory, for materials and use of instruments. An additional charge of $5 is annually made to each student for the use of the College Reading Room and Gymnasium.

IX.

CHURCH SITTINGS.

Free sittings for students in this department of Yale College are provided as follows: in the Center Church (Cong.); in the Trinity Church (Epis.); and in the First Methodist Church.

Those who prefer to pay for a sitting for a year, more or less, in the churches above mentioned, or in any other church of any denomination, will be aided on application to the Secretary of School.

Sittings in the Gallery of the College Chapel are free as heretofore to the students of this department.

X.

DEGREES.

Students of this department, on the recommendation of the Governing Board, are admitted by the Corporation of Yale College to the following degrees. They are thus conferred:

1. Bachelor of Philosophy: on those who complete any of the three-year courses of study, passing all the examinations in a satisfactory manner, and presenting a graduation thesis.

The fee for graduation as Bachelor of Philosophy, including the fee for Triennial Catalogues, Commencement Dinners, etc., is ten dollars; unless the person taking the degree is also an academical graduate, when it is but five dollars.

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2. CIVIL ENGINEER and DYNAMICAL ENGINEER: The requirements for these degrees are stated on page 43.

3. DOCTOR OF PHILOSOPHY: The requirements for this degree are stated on page 42.

XI.

TERMS AND VACATIONS.

The next academic year begins Thursday, September 12, 1878. The first term begins eleven weeks from Commencement-day and continues fourteen weeks: the second term begins on the second Thursday in January and continues until Commencement-day, with a Spring recess—usually of eight days—including Easter. (See Calendar, p. 30.)

XII.

ANNOUNCEMENT IN RESPECT TO STATE STUDENTS.

The scholarships established in this School in consequence of the bestowal upon it of the Congressional grants are designed to aid young men who are in need of pecuniary assistance in fitting themselves for agricultural and mechanical pursuits of life. All applicants must be citizens of Connecticut. In case there are more applicants than vacancies, candidates will be preferred who have lost a parent in the military or naval service of the United States, and next to these such as are most in need of pecuniary assistance: and the appointments will be distributed as far as practicable among the several counties in proportion to their population. The Appointing Board for the current year, consisting of the Board of Visitors of the State and the Secretary of the School, will meet on June 25, 1878, and at or about the same time in the year 1879, due notice of which will be given by publication in every county of the State. All applications should be made previous to that time. Blank forms for application will be sent, when requested, by Professor GEORGE J. BRUSH, Secretary of the Appointing Board.

XIII.

ANNIVERSARY.

The Anniversary of the School is held on Tuesday of the Commencement week in Yale College, when selections from the graduation theses are publicly read. The degrees are publicly conferred by the President and Fellows of Yale College on Commencement Day.

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State Board of Visitors.

CONSTITUTING, WITH THE SECRETARY OF THE SCHOOL, THE BOARD FOR THE APPOINTMENT OF STATE STUDENTS.

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LIEUTENANT-GOVERNOR.

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SECRETARY AND TREASURER OF THE SCHOOL.

GEORGE J. BRUSH.

JANITOR OF SHEFFIELD HALL.

ANTON PFEIFER, 55 Lock street.

JANITOR OF NORTH SHEFFIELD HALL.

GEORGE W. STODDARD, 407 Columbus street.

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THIRTEENTH ANNUAL REPORT

OF THE

SHEFFIELD SCIENTIFIC SCHOOL

OF

YALE COLLEGE,

1878-79.

PRINTED BY ORDER OF THE GENERAL ASSEMBLY.

NEW HAVEN:
TUTTLE, MOREHOUSE & TAYLOR, PRINTERS.
1879.

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REPORT OF THE STATE BOARD OF VISITORS.

To the General Assembly of the State of Connecticut:

The State Board of Visitors of the Sheffield Scientific School have the honor to transmit herewith the Annual Report of the Governing Board of that institution. By it the progress of the school, and the exceeding value of the educational work which it is doing, will be seen at a glance. We take pleasure in saying that a more zealous, devoted and competent staff of professors is not to be found. By their persevering efforts and the noble generosity of Mr. Sheffield, the institution has grown from small beginnings, in an incredibly short space of time, to be as we believe, the most thorough and complete scientific school in the whole country. The people of the State are too little aware of its value, considered merely as a means of industrial education. Let one illustration of its uses stand for many. The people of our State easily excel all others in the inventive faculty. It is this faculty which perhaps more than any other adds to the material comforts and conveniences of social life and to the wealth of the State. Let any one glance at the course of studies taught by this School in Dynamical Engineering as set forth in the present report of the Governing Board, and he will see that it is just what is most wanted to-day for the development and education of the inventive genius of the State and for continued progress in the Mechanical Arts.

We beg leave again to state, as we took occasion to do in our last report,—and we repeat it now for the purpose of giving still more publicity to the fact, and of keeping it constantly alive in the public mind,—that there are no less than thirty scholarships in this school that are to be had by any poor and deserving applicant for the mere asking. A highway is thus opened up from the common schools into optional and special courses of study in the highest ranges of the working sciences, and every poor man's son in the State ought to know it. This fact is one of the most signi-

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ficant and interesting developments in the whole history of modern popular education. It is an added opportunity,—and a very noble one,—for the sons of the poorer classes to emancipate themselves from hard conditions, and pass up into higher and better. In this point of view we regard it as one of the very best tendencies of the democratic institutions of our State. Whilst commending the general merits of this school as most useful and excellent, we beg to emphasize to the utmost this feature of it. There ought to be at least as much competition for these free scholarships as there is for the prizes of a regatta, a ball club, or a target shoot. It does not speak well for the reputation of our State, or the educational spirit of our young men that it is far otherwise.

By order of the Board.

R. D. HUBBARD,
Chairman.

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ANNUAL STATEMENT

OF THE

GOVERNING BOARD.

In presenting their Thirteenth Annual Report, the Governing Board of the Sheffield Scientific School have deemed it wise to call the attention of the Legislature and the public to the facilities now furnished for the study of Mechanical or Dynamic Engineering. The general prostration of business throughout the country has temporarily affected to a large extent, as is well known, the demand for proficients in Civil Engineering. For Dynamic Engineers there is, however, a steady call; and the Governing Board have, during the past year, devoted much attention to improving and perfecting the course of study in this department. It has been thought proper in consequence, to state fully the method of instruction now carried on in this branch; and for it we ask the consideration of those who are interested in the development of engineering applied to the mechanic arts, and of the institutions which seek to prepare young men for the callings in which a theoretical knowledge of the principles of Dynamic Engineering is advantageous, if not absolutely essential.

Course in Dynamic Engineering.

OBJECT OF THE COURSE.

The object of this course is to furnish such a preliminary training as shall best qualify the student to follow with success the profession of a mechanical engineer, to enable him to properly design machinery and to superintend its construction in the shop, and to prepare him as thoroughly as possible, by study and practice, for the various duties which the mechanical engineer may be called upon to fulfill, such as shop management, the testing and examination of machinery, the measurement of the power fur-

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nished by machines, the arrangement of machine plans, and the duties of an expert generally; to furnish him with the ability to put into proper shape the ideas of the constructor and inventor, and, so far as in him lies, to invent new forms and combinations himself.

The dynamic engineer should be both a constructor and an inventor, as well; should combine theoretical knowledge with practical experience; and just in the degree in which he does this will be his chances of success in his profession.

How far these demands can be met in a preliminary course of collegiate instruction, and just what is the best way of meeting them, and of giving to the young student the best possible preparation for the work which lies before him after graduation, are questions which yet wait for solution. The number of the Institutions in which such a course of instruction is attempted, illustrate the diversity of views which prevail, and indicate as well, the wide-spread demand which exists for well trained mechanical engineers. In fact, the field of employment open to the competent graduate in the direction of mechanical engineering, is of wider extent and holds out greater inducements of speedy, permanent and profitable employment, than in almost any other line of technical study. Nearly every branch of commercial and industrial enterprise,—mines, furnaces, mills, ships, railroads and manufactories of all kinds—offer to trained ability, abundant and lucrative occupation, and the prospect of speedy personal independence. The old established course, and the old designation of "Civil Engineer," no longer cover the wide field which has been opened up by the rapid development of later years. As a consequence of such development, which has been mainly due to the introduction of machinery in nearly every direction of human industry, we have the wide-spread demand above alluded to; a demand which it becomes the duty of our technical schools to recognize and provide for, and which, accordingly, as early as 1863, was recognized by the Governing Board of the Sheffield Scientific School by the institution of a separate course of instruction in mechanical engineering.

EQUIPMENT OF THE DEPARTMENT.

The Department now possesses for the purposes of instruction a large and well selected cabinet of Mechanical Models and apparatus, originally the gift of M. Dwight Collier, Esq., of St. Louis, as a memorial of his brother, Thomas F. Collier, who for

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two years previous to his death, in 1868, had been a member of the School. This collection has since been greatly increased by purchases abroad, and by the generous gifts of many friends of the School at home. Through the kindness of Howard Potter, Esq., the School also possesses the entire collection of working plans and drawings of the Novelty Iron Works, numbering several thousand, an accumulation of twenty-five years, illustrating entire and in detail the large variety of constructions there manufactured. A full catalogue of these drawings will be found in the Sixth Annual Report of the School. They have been all brought together, conveniently arranged for reference, and form an invaluable aid in the course of instruction. The libraries both of the College and of the School are free of access to all the students.

RELATION OF THEORY AND PRACTICE.

Such, in brief, is the object of the course, and such are the means at disposal for attaining it. A few words may not be out of place as to the methods pursued in the work of instruction and the reasons which render such methods desirable. As already intimated, a great diversity of views prevails as to what should constitute the best training for a mechanical engineer. Such diversity is perhaps better accounted for by the special circumstances and limitations under which our technical schools are required to work, rather than by any real difference of opinion as to the end to be attained and the subjects necessary to be taught. The object in view, as already stated, is so to train the student in "such branches of learning as are related to the mechanic arts," as to qualify him to contribute toward the more efficient prosecution of these arts and render him able to design, construct, superintend and invent machinery of all kinds. Circumstances must largely mould and regulate the methods by which this end is sought to be attained, as well as the degree in which it is attained. It is, of course, not to be expected that within the limits of a short collegiate course, a full practical knowledge of details of professional work can be acquired. Even were this possible, it is questionable whether the time at disposal would be thus utilized to the best advantage. Principles, not practice, must be ever the leading object, and these principles properly acquired and apprehended, the student can be trusted to acquire the details by the experience which the practice of his profession must inevitably bring. Indeed, it is only by practice and experience that such

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details can be properly learned at all; while without a thorough knowledge of the principles involved, even practice and experience must fail to bring forth their legitimate fruits. A thorough theoretical training is, therefore, an essential, and such it is earnestly endeavored to give. Moreover, at no other time of his life is the student so well able to obtain such a training, while the practical details are the natural growth of years of application of the fundamental principles thus early acquired. At the same time it can not be forgotten that the student has a right to expect something more than a mere theoretical training, however thorough, as the result of five years of earnest labor. He has a right to expect that, upon graduation, he shall have a useful, practical knowledge of professional details, of such an extent as shall render his services immediately and directly valuable, and furnish him with at least the means of subsistence and with immediate employment. This is an essential for any successful technical course. Without it the student might better, so far as any immediate remuneration is considered, start at once in some subordinate position in the shop, and even if in the end the more thoroughly prepared graduate ought, theoretically, to come out ahead of his untrained competitor who started earlier in the shop, he can hardly be expected to properly realize at such an early stage the advantages of such a preparation, nor to give the length of time necessary to practically test its value. Moreover, as a matter of fact, he would not always come out ahead. Earnestness of purpose and the stress of necessity, may often enable the apprentice to outstrip his more favored and sometimes more indolent competitor. With the theoretical training, therefore, it is absolutely essential that so much of detail should be joined, as shall render the student commercially valuable and secure him a standing and a starting place in his profession. So much is necessary. More than this is not essential, although in so far as it does not encroach upon thorough theoretical training, the more of practice the better.

The manufacturer, on the other hand, who may employ such a graduate of a technical institution, has, in turn, a right to expect that his services shall be at least worth his pay, while he is acquiring in the shop those practical details which are necessary to supplement and complete his course. However rapidly his training may enable the graduate student to outstrip his less thoroughly prepared non-graduate competitor, the employer can

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hardly be expected to both teach and support him through this stage of his career, especially when the knowledge thus obtained at his employer's expense goes ultimately to benefit some one else. We cannot thus turn our manufacturing establishments into training schools for the finishing of our graduates and expect them not only to give free tuition, but to pay their students as well. The above remarks are worth the attention of manufacturers, who are sometimes prone to expect too much from a young graduate in the first instance, and to put him at once, on the mere recommendation of his diploma and the reputation of the school from which he gets it, at work for which he is eminently unfit, and then going very naturally to the other extreme, upon the natural failure of the young man to meet these extravagant expectations, to depreciate and undervalue the real worth of the special training and preparation imparted by the school. Let it be understood then, by students and employers alike, that skilled engineers are not and cannot be made to order by this or any other School. A good foundation only can be laid, upon which the student must build for himself according to his own ability, industry, and opportunities, and, in addition to this, he should bring a certain but necessarily very limited amount of special knowledge which ought to be sufficient, at least, to pay his way while he builds. He is well trained in the *science* of mechanics, but has most of his *trade* still to learn. If understood thus, graduated students would often be spared much weary and profitless waiting and their employers much disappointment and perhaps pecuniary loss.

The two objects held in view, then, throughout the course, are 1st, *A thorough theoretical training;* 2d, *A sufficient practical knowledge in certain directions, to secure and to be worth remuneration.*

COURSE OF INSTRUCTION.

These objects are sought to be secured as follows: The full course occupies five years. The first year is, as given elsewhere in this Report, common to all the courses. The second year follows closely the course as laid down for Civil Engineering. The distinction between Civil and Dynamic Engineering, lies in the fact that, while the problems of the first are problems of stability, and involve the necessary condition of rest or permanence, as exemplified in bridges, roofs, dams, earthworks, and the like, those of the second involve the application of motion and force for the performance of desired results, as exemplified in machines

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of various kinds. The object of the one is to resist the action of natural forces, and, even in spite of them, to ensure and secure permanence and stability; of the other, to guide and control the action of these forces and by making use of them, to secure the end in view, which is generally the performance of work or the transmission of motion or power from one point to another. The elementary studies, it is therefore evident, must be to a large extent, common to both branches. The various forces of nature, their laws of action and the methods of investigating and studying them, must be familiar both to the Civil and Dynamic Engineer. As, however, the one has to combat and counteract the action of these forces while the other has to guide and modify their effects, there must be a divergence as the student advances. The second year, therefore, is very similar, as will be seen from the schedule of studies, in both courses, while in the third year there is a marked divergence. Up to this point, the student has obtained a fair knowledge of French and German, of Physics and Elementary Chemistry, is well trained in the Mathematics, including Analytical Geometry and the Differential and Integral Calculus, and has been specially drilled in Instrumental Drawing and Descriptive Geometry. These latter forming as they do, the foundation of his practical training, and being essential to future success, are taught with great thoroughness and in detail. The student learns to represent accurately and to scale, any construction, and to put into concrete form, in the shape of an accurate working drawing, any ideal combination of parts for the attainment of any desired result.

In the third year, the divergence is complete. While in the direction of theory, applying his mathematical knowledge in various directions, such as the application of mechanics to machinery, and becoming familiar with the principles which govern the construction of various machines, such as Steam Engines, Air Engines, etc.; with the fundamental principles of Hydraulics and Hydraulic Motors; the student at the same time pursues an extended course of *machine designing*, in which he learns to apply not only all new principles as he acquires them, but also his knowledge of the Strength of Materials, the Principles of Mechanism and Descriptive Geometry already obtained. He is made to consider one by one all the various parts which all machines possess and their mutual relations; is taught to design them one by one, and, while designing, has pointed out to him their various uses, the

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processes involved in their construction and the rules for proportioning them. Then, passing on from the simple to the more complex, he designs working drawings for projected machines. When rational formulæ are not applicable, empirical rules deduced from the best practice, for the dimensions of the various parts are given him, and the work in the Drawing Room, which forms a very important feature of the course, is conducted as nearly as possible in all respects like that in the draughting room of an engineering establishment. The course is supplemented by shop visits, in and out of the city, and attention is directed to the important points of fitting, founding, forging and pattern-making, and all the principal processes involved in machine construction. By these means, by lectures upon the above processes, and by recitations, it is believed that the student can obtain such a knowledge as shall render him an acceptable and profitable acquisition to the manufacturer and machine constructor. The fourth year continues the course just indicated. In addition to the course elsewhere laid down in this Report, and a special course of reading under the direction of the professor, the student is required to examine and report upon existing machines, to design machines for various purposes according to given data, and to complete his course in the draughting room. Arrangements are made by which such students can make trips upon locomotives and steamboats for the purpose of examination, take indicator diagrams and make reports, and a certain number of such trips and reports are required from every student. The year closes with the preparation and presentation by the student of a thesis upon some special subject, giving evidence of application and ability in the studies he has pursued. The fifth year must be spent by the student either in actual professional practice, in the examination of engineering works and manufacturing establishments, or in some subordinate position in such works or establishments. During this time the student will be in constant communication with the professor and will engage in such work only as shall appear to be favorable to professional progress.

All the lectures of the University which have any bearing upon his profession, are open to the student during the last two years, such as those upon Political Economy, Patent Law, and The Law of Contracts; and opportunity is offered him to take the Field-work with the Civil Engineers, and so much of Practical Astronomy as is requisite for the determination of Latitude and Longitude.

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Connecticut Agricultural Experiment Station.

The Connecticut Agricultural Experiment Station still con-
es to have the use of three rooms and the eastern entrance in
ield Hall. The other appliances of the School have also
freely used, whenever necessary, by this important State
tution, and, as heretofore, free of charge to the Station. This
pation of the eastern wing by the Experiment Station has
e it necessary to provide elsewhere for the increasing wants
ie students of Physiological Chemistry, and another labora-
on the second floor of the western wing has been given up
hat use.

is perhaps proper to add here that the New Haven County
iers' Club has had the free use of rooms in Sheffield Hall, for
meetings. This association holds eighteen regular meetings
year, viz: on the first and third Fridays of each month
October to April, and on the first Friday of each month
ig the other six months. The meetings have been large and
attended.

e New Haven County Agricultural Society has also had the
f rooms for its meetings.

National Agricultural Congress.

e National Agricultural Congress held its annual meeting in
h Sheffield Hall, beginning August 27th, 1878.

e sessions continued three days, and were attended by a large
ber of persons representing many States of the Union.

Public Lectures.

e twelfth annual course of lectures to mechanics and others
given during the past year in the lecture room in North
ield Hall. The lecturers and their subjects are indicated in
llowing programme.

Thurs., Feb.	7.—British Savings Banks.	Prof. Walker.
Monday, "	11.—Ferns.	Prof. Eaton.
Friday, "	15.—The Story of the Northumbrian Gospels.	Prof. Lounsbury.
Monday, "	18.—The Great Pyramid.	Prof. J. D. Whitney, of Harvard College.
Thurs., "	21.—Torpedoes.	Gen. H. L. Abbot, U. S. Engineer Corps.
Monday, "	25.—Development of Oöspores in Seaweeds.	Prof. Eaton.
Thurs., "	28.—Quetelet's Researches on Man.	Prof. Clark.

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VIII. Mon., Mar.	4.—The Atomic Theory.	Prof. Johnson.
IX. Thurs., "	7.—History of the Art of Writing.	Prof. W. D. Whitney.
X. Monday, "	11.—American Savings Banks.	Prof. Walker.
XI. Thurs., "	14.—Relations of Meteorites to Comets.	Prof. Newton.
XII. Monday, "	18.—Niagara Falls.	Prof. Brewer.
XIII. Thurs., "	21.—Niagara Falls.	Prof. Brewer.

Lectures on Military Science.

A course of lectures on military science, by officers of the U. S. Engineering School, at Willet's Point, was delivered in North Sheffield Hall as a part of the instruction in the school during the second term of the academic year 1877–78. The order and subjects of the lectures were as follows:

I. Friday, Feb.	1.—Strategy and Grand Tactics.	Capt. W. D. Livermore, U. S. Engineers.
II. Tuesday, "	5.—Logistics.	Capt. T. H. Handbury, U. S. Engineers.
III. Friday, "	8.—Small Arms and their influence on Tactics.	Lieut. B. D. Greene, U. S. Engineers.
IV. Tuesday, "	12.—Ordnance and Gunnery.	Lieut. J. B. Quinn. U. S. Engineers.
V. Friday, "	15.—Fortification.	Capt. A. M. Miller, U. S. Engineers.
VI. Thurs., "	21.—Torpedoes.	General H. L. Abbot, U. S. Engineers.

Gifts.

A binocular compound microscope, with case and accessories, made by Beck, has been presented by Alonzo E. Wemple, Esq., of the class of 1875, and is a valuable addition to the apparatus of the Biological department of the School.

A complete set of the American Journal of Education, extending from 1855 to 1877, and embracing twenty-seven volumes, has been presented to the library of the School by Mr. Sheffield.

To Dr. Wolcott Gibbs, Rumford Professor of the Application of Science to the Useful Arts in Harvard University, the Library is also indebted for a generous gift of about one hundred and fifty volumes. The following is the list of the works presented.

Accum, F. Elements of Crystallography. London, 1813.

Agriculture, Department of. Reports for 1873 and '75. 2 vols. Washington 1874 and '76.

American Almanac. 1830–61. 32 vols., bound in 19 vols. Boston, 1829–61.

American Association for the Advancement of Science, Proceedings of the. 1845, '48–'51, '53, '55–'60, and '67. 15 vols.

American Chemical Society, Proceedings of the. New York, 1876.

American Geographical Society of the State of New York, Journal of the. 1870–71. New York, 1873.

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Astor Library, Catalogue of the. 4 vols. New York, 1857–59 and '61.
Bulletin de la Société Chimique. 1861–72. 14 vols. Paris, 1861–72.
BURAT, M. A. Géologie Appliquée. Paris, 1846.
Canada, Geological Survey of. Reports 1853–56. Toronto, 1857.
Canadian Meteorological Report for 1876. Ottawa, 1877.
COX, E. T. Geological Survey of Indiana. Reports for 1873 and 1875. 2 vols. Indianapolis, 1874 and 1876.
DALE, T. N. Study of the Rhaetic Strata of the Val Di Ledro. Patterson, 1876.
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From Mr. D. Cady Eaton, late Professor of the History and Criticism of Art in Yale College, the School has received a gift of the following large-size photographs of artizan work of the Middle Ages, and of later periods. The objects from which these photographs are taken, are contained in the National Museum of Bavaria, at Munich, and, as will be seen, comprise artizan work of a military, ecclesiastical, and domestic character.

1. Complete suit of Armor of Duke Henry the Pious of Saxony, born 1473, died 1544. Armor of steel inlaid with gold.
2. Complete suit of Armor of the Elector, Christian I. of Saxony, born 1560, died 1591. Steel etched with gold inlaid.
3. Complete suit of Armor of the Elector, Christian II. of Saxony, born 1583, died 1611. Italian work. Enchased in steel and gilded.
4. Complete suit of Armor of the Elector, Christian II. of Saxony, born 1583, died 1611. Wrought by Kollman in Augsburg. Enchased in steel overlaid with gilt ornaments.
5. Complete suit of Armor of Duke John William of Weimar, born 1530, died 1573. Steel etched and gilded.
6. Parade-armor of the Elector, Christian I., born 1560, died 1591. Copper gilded.
7. Parade-armor of Charles Emanuel, Duke of Savoy, born 1562, died 1630. Enchased in steel and gilded. Made in Milan.
8. The so-called Milan armor introduced into Germany by the Emperor Maximilian I. Made at Nuremberg, 1512–1545.
9. The same, from a different view.
10. Armor for a tournament on foot. Augsburg work. Etched upon steel.
11. Shield of the 16th Century. Augsburg work.
12. Shield of the 16th Century. Augsburg work.
13. Shield of the 16th Century. Italian work.
14. Hauberks of the 17th Century. Steel with silver inlaid, and steel-gilt with silver ornaments. 2 figures.
15. Helmet, 1460–1500.
16. German tournament-helmets, 1500–1550. 2 figures.
17. Milan Helmets, so-called. Nuremberg work, 1515–1540. 2 figures.
18. German Helmet with etched ornaments, 1550–1580.
19. Helmets of the 16th Century. Italian work. 2 figures.
20. Helmet (Spanish model) of the 16th century. Augsburg work.
21. Morions, 1590–1630. 2 figures.
22. Halberds, with wheel lock pistols, 1530–1560. 2 figures.
23. Halberds, etched and gilded, of the year 1588, and two of the same with double pistols. 3 figures.
24. Halberds with etched ornaments, 1550–1590. 5 figures.
25. Halberds and Partisans with etched ornaments, 1600–1640. 4 figures.
26. Indian Partisans bought in the year 1727 by Augustus the Strong. 2 figures.
27. Pistols of Saxon princes of the 16th Century. 4 figures.
28. Pistols of Saxon princes of the 16th Century. 4 figures.
29. Pistols of Saxon princes of the 16th Century. 4 figures.

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30. Pistols of Saxon princes of the 16th Century. 4 figures.
31. Battle-axes, etched, 16th Century. 4 figures.
32. Battle-axes (for making a breach), 16th Century. 2 figures.
33. Battle-axes, etched, gilded, and damaskeened, 16th Century. 4 figures.
34. Carved Iron Parade Swords, with gold and silver inlaid, 1590–1640. 3 figures.
35. Gilt Iron Sword-hilts, gilded, 16th century. 3 figures.
36. Carved Iron Sword-hilts, gilded and inlaid with silver, 16th Century. 3 figures.
37. Carved Iron Sword-hilts. Nuremberg, 16th Century. 3 figures.
38. Carved Iron Sword-hilts, 16th Century. 4 figures.
39. Carved Iron Daggers, with Tauschir work in gold and silver. 8 figures.
40. Hangers with handles of stag-horn, ivory, and mother-of-pearl, 1700–1750. 9 figures.
41. Powder-flasks of stag-horn, 1550–1600. 8 figures.
42. Powder-flasks of ivory, 1670–1720. 9 figures.
43. Hunting-horn of the Roman time. Hunting-horn of the 17th Century. Powder-horns. Indian work of the 17th Century. 4 figures.
44. (*a*) Frontlet-armor of a horse, fluted, part of the Milan suit of armor. (*b*) Frontlet-armor of a horse, from the castle of Hohenaschen, with the escutcheon of the Lords of Freyberg, 1520–1540. 2 figures.
45. Embroidered Old-German Saddle with pistol holsters, 16th Century.
46. Old-German Saddle and Stirrups, 17th Century.
47. Spurs of Duke Christopher of Bavaria, with the Stirrups of silver-gilt. 2 figures.
48. Tools of the Elector Augustus, 16th Century. 4 figures.
49. Order of the Dragon, established by the Emperor Sigismund, 1389. Raised embroidery of silk and gold.
50. Gilded Badges of lead and bronze casting, and bronze ornaments, 1613–1661.
51. Monile of copper-gilt, with adoration of the three kings, wrought in silver, 1380–1440. 2 figures.
52. Bronze Reliquary, 1000–1050.
53. Fragments of an ivory Reliquary from the cathedral at Bamberg, 1000–1020. 3 figures.
54. Bronze Reliquary, 1000–1050.
55. Copper-gilt Reliquary, engraved and enamelled, 1150–1200.
56. Copper-gilt Reliquary, engraved and enamelled, 1170–1210.
57. Wooden Reliquary, 1460–1480.
58. Altar-piece in painted wood. Sculpture by Michael Bacher of Brunck, 1480–1500.
59. Painted wooden Altar-piece. After a design of Martin Schongauer, 1486.
60. Small Altar-piece in carved wood. Low Dutch school, 1490–1510.
61. Painted wooden Altar-piece with wings, 1500–1510.
62. Copper Pyx, fire-gilt, 1400–1430.
63. Iron Pyx, 1460–1500.
64. Monstrances of copper-gilt, 1460–1500. 3 figures.
65. Bishop's Crosier of ivory, 1710–1740.
66. Mitre with orient pearls. Mitre embroidered with silk, from the cathedral at Meissen, 15th century. 2 figures.

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67. Two ivory Diptychs, and parts of Diptychs, 1300–1350. 7 figures.
68. Ivory Diptychs and parts of Diptychs, 1300–1350.
69. Painted wood Statue. St. Walpurgis, 1480–1500.
70. Painted wood Statue. St. Magdalen, 1480–1500.
71. Painted wood Sculpture. Lamentation over the body of Christ, 1490–1510.
72. Sculpture from Pear-tree wood. The Burial of Christ, 1496.
73. Painted wood Sculpture. The Body of Christ, the Virgin Mary, and St. Roch, 1500–1520.
74. Wood Sculptures of Fielman Riemenschneider. St. Peter, St. Paul, St. Simon, and St. Andrew, 1500–1520.
75. Wood Sculptures by the same. St. John, St. Philip, St. Bartholomew, and St. Thomas, 1500–1520.
76. Wood Sculptures by the same. St. Matthias, St. Jude, St. James the Greater, St. James the Less.
77. Painted wood Sculptures. The Four Evangelists, 1520-1540.
78. Painted wood Sculpture. Death of the Virgin Mary, 1580–1600.
79. Wood Sculpture. (*a*) Milan Coat-of-arms with lancers as shield supporters. From the castle at Passau. (*b*) End Rosette of a wooden ceiling.
80. Wood Busts from the castle at Neuberg, 1520–1540. 2 figures.
81. Linden-wood Sculptures. Two Knights of Leoprichting, 1520–1540.
82. Alabaster Sculpture. The Annunciation, 1460–1480.
83. Ivory work. Munich school, 1600–1650. 3 figures.
84. Ivory work. Munich school, 1600–1650. 3 figures.
85. The same, another view.
86. Ivory work, 1630–1660. 3 figures.
87. Ivory Sculptures. Bacchanals, by Antonius Leoni of Venice, 1690–1700.
88. Group of painted Porcelain. Frankenthal make, 1755–1761.
89. Oak-wood Ornaments. 1440–1480.
90. Linden-wood Ornaments, 1530–1560. 5 figures.
91. Linden-wood Ornaments, by Peter Floetner of Nuremberg, 1520–1546. 10 figures.
92. Ornaments of wrought Iron, 1700–1740. 8 figures.
93. Lead Castings from the work-shops of Nuremberg and Augsburg artificers as models for gold and silver smiths, 1560–1620. 10 figures.
94. Middle and Corner Borders of Book-covers, brass casting. 12 figures.
95. Fibulae of bronze, silver, and gold from the graves at Nordendorf, 500–900. 23 figures.
96. Silver Ornaments, 1640–1710. 49 figures.
97. Silver Ornaments for women. Girdles with knife-sheaths, 1660–1720. 2 figures.
98. Mother-of-pearl work, 1450–1500. 28 figures.
99. Silver Filagree work, 1660–1740. 26 figures.
100. Silver Filagree work, 1660–1740. 14 figures.
101. Linen with embroidered ornaments, 1380–1400. 3 figures.
102. Cloth Tapestry with figures representing the Beheading of John the Baptist, and the Twelve Months, 1560–1590.
103. Canvas Tapestry, 1590–1620.
104. Linen and Lace Table-cover. After the designs of Siebmacher, 1600–1640.

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cloth of white Lace embroidered with gold, 1600–1650.
of the Schramonplatz at Munich. Painting on linen in water colors,
t.
of Gold woven with silk, 1690–1720.
l of Violet-colored Velvet embroidered with gold, of Duke William V.,
ch he wore at his marriage with Reneé of Lorraine, Feb. 22, 1568.
at view.
ame, view of the back.
ait of Duke Louis of Bavaria, brother of William IV., painted by Hans
linger, 1516.
ary Bag of the Elector, Maximilian I., of Bavaria.
s' leather Work-bags, 1510–1540. 3 figures.
l Letters on Parchment, 1490–1510.
di Gamba of the Elector, John William of the Palatinate, made by
him Filke in Hamburg, 1697.
-board of wood, and painted, 1490–1510.
-board with inlaid engraved sculptured ivory, mother-of-pearl, and
l. After designs by Georg Penz, Heinrich Aldegrever, and Hans
ld Behan, 1520–1540.
ame. View of the inside.
ammon Board. Pieces containing portraits of German princes, 17th
tury.
ing Clock, wrought and chiselled in silver, made by Christopher
nde, in Augsburg, 1650–1670.
of the 17th Century.
ng-glass, with Frame carved from pear-tree wood. Dutch work,
)–1600.
e carved in knee-timber, 1620–1640.
ental Cabinet of ivory and copper-gilt, 800–900.
wooden Chest with colored lining, 1440–1470.
with gilded lead filagree work, 1440–1480.
n-wood Chest with colored lining, 1460–1480.
r Chest of iron, etched, 1560–1590.
r Chest of iron, with colored lining, 1480–1510.
d and inlaid Chest, with piano-forte, 1580–1620.
n Luther's Cabinet. Gift of the Elector, John Frederick, 16th Century.
Stove-Tile, with colored glazing, 1460–1500.
and of wrought iron of the Elector, Charles Theodore of Bavaria,
)–1790.
ing-wheels, 1620–1660. 2 figures.
s with carved work, and with the coat of arms of the Lords of Imhof,
)–1590. 3 figures.
s with carved work, 1560–1600. 3 figures.
of Venetian glass, 1550–1600.
sin Plates by Pierre Cortoys, 1558. 2 figures.
lates of Caspar Enderlein, Nuremberg, 1600–1620. 2 figures.
top of a piece of Cypress-wood, Nuremberg, 17th Century.
ankards, 1540–1600. 4 figures.

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141. Cologne Pitchers of stone-ware, 1569–1591. 4 figures.
142. Cologne Pitchers of stone-ware, 1600–1630. 3 figures.
143. Mass Service of rock crystal and silver-gilt, 1600–1630. 2 figures.
144. Venetian Glasses, 1580–1600. 3 figures.
145. Venetian Glasses, 1650–1700. 3 figures.
146. Venetian Glasses, 1650–1700. 5 figures.
147. Glass Drinking-cup, with colored and gold ornaments and figures burnt in; made at Damascus, 1260–1300.
148. Drinking-horn of the 15th Century.
149. Silver Drinking Cup of the Burgomaster Gletzle of Ingolstadt, 1450–1470.
150. Drinking Cup of silver coin of Duke John George of Saxony, 1634. Ivory Drinking Cup with silver-gilt stand and cover of the same period. 2 figures.
151. Drinking Cups of carved cocoa-nut wood, 17th Century. 3 figures.
152. Ivory Drinking Cup with silver-gilt stand, cover, and handle. Munich work, 1630–1660.
153. The same. Another view.
154. Silver Drinking Vessels. One a Wedding Beaker in the form of a woman. No date. 3 figures.
155. Ivory Goblet and Candle-sticks, 1680–1700. 3 figures.
156. Bronze Candlesticks, 1100–1150. 3 figures.
157. Candlesticks of cast bronze, 1140–1200. 3 figures.
158. Turned ivory Candlesticks of the Elector, Maximilian I. of Bavaria, 1620–1640. 3 figures.
159. Ivory Knife and Fork Handles, 1680–1720. 18 figures.
160. Hunting Knives of the 17th Century. 5 figures.
161. Keys, 1650–1700. 15 figures.
162. Lock of a Bridal Chest with etched ornaments, 1530–1550.
163. Lock of a Bridal Chest with etched ornaments, 1530–1550. Tinned.
164. Lock-smith work, 1540–1580. 4 figures.

The following gifts have been made to the Department of Dynamic Engineering:

One No. 1 Sturtevant Blower, from B. F. Sturtevant, of Boston; one tablet of machine-made set-screws, from the Hartford Machine Screw Co.; Babbitt boxes for connecting rod, from the Colt's Pat. Fire Arms Mfg. Co., of Hartford; and one book of shapes (catalogue) from the Union Iron Co., of Buffalo, N. Y., by the favor of H. B. Bigelow, Esq., of New Haven.

Additions to the Zoological Collection.

A. E. Verrill, Curator; E. B. Wilson, Assistant.

During the past year rapid progress has been made in the arrangement, mounting and labelling of the collections. In the room (No. 12) devoted to vertebrata, the arrangement of the birds, reptiles and fishes has been nearly completed and many

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additions have been made, particularly to the special New Eng-
hile as many of the more interesting or important of
ird skins as our very limited funds would permit have
l. In room No. 16, numerous additions have been
nost of the corals and echinoderms, and many of the
have been permanently mounted on bases. For this
tablets, one-half and three-quarters of an inch thick,
l edges, and painted pale gray, have been adopted.
of corals, with large or irregular bases, it has been
onvenient to form around them a tablet of the same
olor, consisting of plaster of Paris and hydraulic
ed with suitable pigments. The echinoderms and
nounted shells are held upright by silver-plated brass
sly attached according to the subject. Most of the
s been done very neatly and skillfully by Mr. E. H.

e summer vacation, as in seven previous years, the
charge of the dredging, carried on by the U. S.
sion, and as usual the large collections of inverte-
nt here for elaboration. Mr. Richard Rathbun and
n Smith, were the principal assistants during this
headquarters were at Gloucester, Mass., and the
were to the eastward and southward of Cape Ann,
chusetts Bay. When fully studied, a series of these
ll be deposited in the Museum, by the curator.
e most important additions received this year is a
of British crustacea, shells, polyzoa, and sponges,
named, and sent by the Rev. A. M. Norman, in

Emerton, Salem, Mass., presented specimens of a rare
a Packardii) from Mt. Washington.
Punderford gave a squid (*Loligo*) from New Haven.
Foote & Co., New Haven, presented a seal (*Phoca*
en at Tomlinson's Bridge, in New Haven harbor.
cluster of oysters.
Beecher, New Haven, gave a hen's egg, containing
l, inside the outer one, and separated from it by a
men.
Mixter (S. S. S. 1877) presented insects, crustacea,
a from Illinois.
Morse, in behalf of the University of Tokio, Japan,

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gave, in exchange, a collection of corals, shells, alcoholic mollusca, crustacea, and other marine invertebrates from the Bay of Yeddo; also a "broad tape-worm" (*Bothriocephalus latus*) from Tokio.

Prof. S. W. Johnson presented a *Mermis* dug from the earth in his garden.

Miss J. M. Harrington, New Haven, gave three species of echini from Nassau, N. P.

Prof. O. C. Marsh presented a lot of fishes and marine invertebrates from Southern California, collected by Mr. G. W. G. Harford. Also a snake from Acapulco.

Messrs. Thompson Brothers, Morris Cove, presented a bill-fish (*Belone*) from the harbor.

Lieut. W. B. Pease, U. S. A., gave a collection of skins of mammals and birds, and a few birds' nests from Nebraska.

Capt. John H. Mortimer, New York, presented a very interesting collection of pelagic invertebrates (pteropods, *Lepas*, *Halobatis*, etc.) in alcohol.

Prof. O. D. Allen gave a "copper-head snake" (*Ancistrodon contortrix*) killed at Pine Rock, near New Haven, June 7.

Mr. W. G. Brown (S. S. S.) gave, in exchange, *Squilla empusa* and *Libinia dubia* from near New Haven.

Mr. Robert Veitch, New Haven, presented specimens of a "Japanese earth-worm" (*Perichæta*) from plant-pots in a greenhouse.

Mrs. Hume, New Haven, presented two nests of weaver birds from Bombay.

Major Todd gave a monstrous fœtal pig, said to have been taken from a "boar," New Haven.

Dr. H. Hotchkiss, New Haven, skins of ermine and squirrel from near New Haven.

Mr. Fred. Habershaw, 6 W. 48th st., New York, gave a volume, containing a general list of Diatomaceæ, written by means of an electrical pen.

Mr. S. F. Clark sent living specimens of a rare fresh-water hydroid (*Cordylophora lacustris*) from near Baltimore.

Mr. Henry Turner, Vineland, N. J., sent a lot of marine and fresh-water crustacea, leeches, etc., mostly from New Jersey.

Mr. S. W. Williston presented a lot of Amphipods, from Lake Como.

Mr. A. D. Cobb gave a holothurian (*Thyone briareus*) from West Haven.

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Mr. E. H. Hawley gave a lot of insects, fresh-water shells, fishes and crustacea, from Fulton County, N. Y.

Mr. Howland Briggs sent some brook trout from Fulton Co., N. Y.

Mr. C. Jerome presented fishes and insects from Saratoga Co., N. Y.

Dr. I. P. Trimble presented specimens of Italian marble, deeply perforated and honey-combed by a sponge (*Cliona sulphurea* V.). It was taken from a vessel wrecked off Long Island in 1871.

Mr. J. B. Kirby gave a round-clam (*Venus mercenaria*) containing a large purple "pearl," from New Haven.

Mr. E. B. Wilson (S. S. S.) presented a lot of barnacles (*Balanus improvisus* and *B. eburneus*) on oysters from New Haven.

Mr. Richard Fellowes, New Haven, presented a "lady-fish" (*Albula conorhynchus*) from Newport, R. I.

Mr. F. S. Smith gave a cast skin of black snake.

Prof. J. D. Dana presented a skin of an arctic seal (*Pagomys fœtidus*) from Cumberland Gulf, received from Mr. O. T. Sherman.

Prof. O. C. Marsh deposited a mounted California sea-elephant.

Mr. W. R. Girard sent sponges from Staten Island.

Prof. W. B. Dwight, Vassar College, sent a coral (*Stylaster elegans* V.) from Ebon Island.

Small collections of insects have been received from Mr. W. A. Silliman, Mr. Morton, Mr. H. C. Kingsley, Mrs. E. A. Brown, Mr. C. W. Canfield, K. Mitsikuri (S. S. S.), E. H. Hawley, H. F. Bassett, E. T. Owen, T. A. Bostwick, A. C. Hill, F. S. Smith, E. S. Beecher, H. G. Lewis, C. H. Merriam, D. B. Lane, Misses Lee, Professor G. J. Brush, Professor W. H. Brewer.

Small lots of shells have been presented by Mr. Fred. C. Gorham, Chas. W. Blackman, Geo. W. Hawes, Arthur F. Gray, Orrin Mallory.

A number of East India corals were purchased from Mr. W. J. Knowlton.

Mr. J. F. Whiteaves has sent to the curator portions of a new coral (*Paragorgia Pacifica* V.) from near Vancouver Island, for description.

Prof. A. E. Verrill has deposited many rare corals, etc., and a number of rare fishes, including a skeleton of the recently discovered *Chimæra plumbea*, from deep water off Nova Scotia. Collected by the U. S. Fish Commission.

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ANNIVERSARY.

The Anniversary exercises were held in North Sheffield Hall on the evening of Tuesday, June 25, 1878. The candidates for degrees with the subjects of their graduation theses are given in the following schedule. Those marked with an asterisk were read in the evening.

CIVIL ENGINEER. (1)

DANIEL WEBSTER HERING, Ph.B. *Johnsville, Md.* On Iron Substructures for Railways and Bridges.

BACHELORS OF PHILOSOPHY. (39)

WILLIAM DAY ALLEN (Select), *Hartford.* On Chinese Immigration.

* SEYMOUR LANDON ALVORD (Select), *West Winsted.* On Tramps.

* JOHN POMEROY BARTLETT (Select), *New Britain.* On the Mohammedans in Spain.

* JOHN LUIS BLACKMORE (Civil Engineering), *City of Mexico, Mexico.* On the Sewerage System of Providence, R. I.

EDWARD EVERETT BREWSTER (Chemistry), *West Cornwall.* On the Determination of Lead in Ores.

FAYETTE WILLIAMS BROWN (Select), *Yonkers, N. Y.* On the Coinage of the United States.

WILLIAM TYLER BROWNE (Biology), *Lisbon.* The Nervous System of Bufo Americanus compared with that of Rana Palustris.

LUCIEN LOWBER BURROWS (Select), *Decatur, Ill.* On Banking in the Western States.

CHARLES WILLIAM CANFIELD (Biology), *Hartford.* On the Heart of Cistudo Virginea.

ROBERT WILLIAMS CHAPIN (Civil Engineering), *Springfield, Mass.* On the Harlem Railroad, between 42d st. and 133d st., New York City.

* WILLIAM GROVER CHAPIN (Dynamic Engineering), *Somers.* On the Pumping Machinery of the New Haven Water Company.

* CHARLES SAMUEL CHURCHILL (Civil Engineering), *New Haven.* A Comparison of the Different Methods of Leveling.

* WALTER LINSLEY COWLES (Civil Engineering), *Wallingford.* A Review of the Gilbert Elevated Railway.

AUGUSTUS JAMES EMERY (Dynamic Engineering), *Bangor, Me.* On Magneto-Electricity.

GRANGER FARWELL (Select), *Chicago, Ill.* On the Origin and Characteristics of Euphuism.

* OSWIN HART DOOLITTLE FOWLER (Select), *North Haven.* On the Character of Richard the Third,

CADMUS ZACCHEUS GORDON (Select), *Brookville, Pa.* On Adams and Jefferson.

LEONARD VASSALL GREENE (Agricultural), *Norwich.* On Tea; its Cultivation at home and abroad.

RALPH AUGUSTUS HARMAN (Civil Engineering), *Cleveland, O.* On the Superior Street Viaduct, Cleveland, O.

WALTER TILLMAN HART (Select), *New Haven.* On the Newfoundland Fisheries.

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GEORGE STEWART HEGEMAN (Select), *Brooklyn, N. Y.* On Heredity, Physiologically and Psychologically Considered.

CHARLES BETTS HILLHOUSE (Select), *New Haven.* On the Power of the House of Commons over the Public Purse.

ROBERT SAMUEL HULBERT (Civil Engineering), *West Winsted.* On a Method of Determining Time and Latitude by the Engineer's Transit.

THOMAS MASTIN JACKS (Chemistry), *Helena, Ark.* On the Chemical Reaction Involved in Gold and Silver Assaying.

FRED. BECKWITH JILLSON (Agricultural), *Whitehall, N. Y.* On Irrigation.

EDWARD CHARLESS LEBOURGEOIS (Dynamic Engineering), *St. James Parish, La* A Mechanical View of Sugar Manufacture.

GEORGE WEBB MASON (Select), *Orange, N. J.* On the Development of Modern Musical Instruments.

WILLIAM JAMES PERRY MOORE (Dynamic Engineering), *New Britain.* On Cable-Making as Applied to the Brooklyn Bridge.

FRANK TURNER MOORHEAD (Select), *Pittsburgh, Pa.* On Gold; its Mining and Uses.

GEORGE HENRY POTTS (Select), *Pittstown, N. J.* On Constitutional Reform in the New England States.

EDWARD TOWNSEND REED (Select), *Albany, N. Y.* On the History of the National Debt of the United States.

CHARLES THEODORE RICHMOND (Select), *Johnsonville, N. Y.* On the Cotton Manufacture.

EDWARD KILBOURN ROBERTS (Select), *New Haven.* On the History of the Labor War, and its Effects upon Employers and Employed.

EDWARD HUBBARD RUSSELL (Dynamic Engineering), *New Haven.* On the Strength of Iron and Steel with reference to Bridge Construction.

EDWARD HERNDON SMITH (Chemistry), *Brooklyn, N. Y.* On the Separation of Iron from Manganese.

WILLIAM ANNIN VLIET (Select), *Cleveland, O.* On the Diplomatic and Consular System of the United States.

EBIN JENNINGS WARD (Civil Engineering), *Marseilles, Ill.* On the Proposed Illinois Ship Canal.

* EDMUND BEECHER WILSON (Natural History), *Geneva, Ill.* Monograph on the New England Pycnogonidæ.

* FRANCIS DANA WINSLOW (Select), *Washington, D. C.* On the Method of Electing the President of the United States.

PRIZES.

The following prizes were announced at this anniversary:

CLASS OF 1873.

For Excellence in German, the prize awarded to JOHN P. BARTLETT, *New Britain.*

For Excellence in French, the prize awarded to EDWARD H. SMITH, *Brooklyn, N. Y.*

For Excellence in Civil Engineering, the prize awarded to WALTER L. COWLES, *Wallingford.*

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CLASS OF 1879.

xcellence in the Mathematics of Junior Year, the prize awarded to GEORGE A SAUNDERS, *Newport, R. I.*, with honorable mention of CHARLES A. WILCOX *Painesville, O.*

xcellence in Chemistry, the prize awarded to WILLIAM J. COMSTOCK, *Toledo O.*, with honorable mention of JOHN JEWETT, *Brooklyn, N. Y.*

xcellence in Mineralogy, the prize awarded to FREDERICK I. ALLEN, *Auburn N. Y.*

CLASS OF 1880.

xcellence in all the Studies of Freshman Year, DWIGHT PORTER, *Hartford.*

xcellence in German, the prize divided between ERNEST T. LIEFELD, *New Haven*, and DWIGHT PORTER, *Hartford.*

xcellence in Mathematics, the prize awarded to DWIGHT PORTER, *Hartford.*

xcellence in Physics, the prize awarded to DWIGHT PORTER, *Hartford.*

xcellence in Mechanical Drawing, the prize awarded to GEORGE ROBER FERGUSON, *New Haven.*

CLASS OF 1881.

best Entrance Examination, the prize awarded to ETHAN ALLEN ANDREWS *Tarrytown, N. Y.*

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PROGRAMME OF STUDIES,

AND

CATALOGUE,

FOR THE COLLEGE YEAR 1878-79.

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PROGRAMME OF STUDIES,

AND

CATALOGUE,

FOR THE COLLEGE YEAR 1878-79.

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CALENDAR.

'8.		
.	Thursday,	First Term begins.
	Thursday,	First Term ends.
'9.		**Winter Vacation of three weeks.**
	Thursday,	Second Term begins.
l,	Wednesday,	Spring Recess begins.
l,	Wednesday,	Spring Recess ends.
,	Tuesday,	Meeting of Appointing Board.
,	Tuesday,	Anniversary.
,	Thursday,	Commencement.
,	Friday,	Examination for Admission.
,	Saturday,	
		Summer Vacation of eleven weeks.
Sept.	Tues., Wedn.,	Examination for Admission.
.	Thursday,	First Term begins.
	Thursday,	First Term ends.

ABBREVIATIONS.

S. H.	Sheffield Hall.
N. S. H.	North Sheffield Hall.
TR.	Treasury Building.
D.	Durfee College.
F.	Farnam College.
D. H.	Divinity Hall.
W. D. H.	West Divinity Hall.
P. M.	Peabody Museum.
A.	Absent on leave.

buildings belonging to the Sheffield Scientific School, the rooms num-
m 1 to 21 are in Sheffield Hall: from 26 to 58 in North Sheffield Hall.

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CORPORATION.

PRESIDENT.

Rev. NOAH PORTER, D.D., LL.D.

FELLOWS.

CELLENCY RICHARD D. HUBBARD, LL.D., HARTFORD.
NOR FRANCIS B. LOOMIS, NEW LONDON.
EONARD BACON, D.D., LL.D., NEW HAVEN.
HEODORE D. WOOLSEY, D.D., LL.D., NEW HAVEN.
IRAM P. ARMS, D.D., NORWICH TOWN.
EORGE J. TILLOTSON, M.A., WETHERSFIELD.
LIVER E. DAGGETT, D.D., HARTFORD.
LPHONSO TAFT, LL.D., CINCINNATI, O.
MOS S. CHESEBROUGH, M.A., DURHAM.
YRON N. MORRIS, M.A., WEST HARTFORD.
ILLIAM M. EVARTS, LL.D., NEW YORK CITY.
ILLIAM B. WASHBURN, LL.D., GREENFIELD, MASS.
AMUEL G. WILLARD, M.A., COLCHESTER.
ENRY B. HARRISON, M.A., NEW HAVEN.
OSEPH W. BACKUS, M.A., THOMASTON.
OSEPH H. TWICHELL, B.A., HARTFORD.
ILLIAM WALTER PHELPS, M.A., NEW YORK CITY.
ASON YOUNG, M.A., NEW YORK CITY.

SECRETARY.

FRANKLIN B. DEXTER, M.A.

TREASURER.

KINGSLEY, M.A. (5 TR.) 23 Hillhouse av.

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GOVERNING BOARD.

APPOINTED BY THE CORPORATION OF YALE COLLEGE.

President.

)AH PORTER, D.D., LL.D., (7 TR.) 31 Hillhouse av.

Chairman and Executive Officer.

E J. BRUSH, (3 S. H.) 14 Trumbull st.

Professors.

ARRANGED IN THE ORDER OF THEIR GRADUATION.

.M A. NORTON,
l Engineering. (34 N. S. H.) 72 Prospect st.

:R S. LYMAN,
sics and Astronomy, Theoretical and Practical. (39 N. S. H.) 88 Trumbull st.

.M D. WHITNEY,
nistics and French. (205 D.) 246 Church st.

E J. BRUSH,
ralogy. (3 S. H.) 14 Trumbull st.

L W. JOHNSON,
retical and Agricultural Chemistry. (12 S. H.) 54 Trumbull st.

.M H. BREWER,
iculture (NORTON *Professor*). (4 S. H.) 246 Orange st.

E. CLARK,
hematics. 29 Eld st.

, C. EATON,
ny. (14 N. S. H.) 70 Sachem st.

S R. LOUNSBURY,
lish. (6 S. H.) 22 Lincoln st.

EL C. MARSH,
ontology. (8 P. M.) New Haven Hotel.

IS A. WALKER,
tical Economy and History. (40 N. S. H.) 68 Whitney av.

D. ALLEN,
lytical Chemistry and Metallurgy. (13 S. H.) 189 Temple st.

N E. VERRILL,
ogy and Geology. (15 P. M.) 148 College st.

I. SMITH,
parative Anatomy. (14 P. M.) 148 College st.

M G. MIXTER,
nistry. (8 S. H.) 8 Trumbull st.

DU BOIS,
amical Engineering (HIGGIN *Professor*). (45 N. S. H.) 328 Howard av.

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URERS, INSTRUCTORS AND ASSIS

ADDITIONAL TO THE GOVERNING BOARD.

S. WHEELER,
an.
AILEY,
tion. (150 F.) 1
NIEMEYER, Professor in Yale School of Fine Arts,
Hand Drawing.
ICK R. HONEY,
iptive Geometry and Projection Drawing. (53 N. S. H.)
IARGER,
ntology. (9 P. M.) 14
J. SKINNER,
matics.
H. EDGREN,
k.
W. HAWES,
alogy. (2 P. M.)
F. KLEIN,
atics and Machine Design. (45 N. S. H.)
B. WILSON,
ry, 5
WATSON,
ying.
L. PENFIELD,
tical Chemistry.
T. SEDGWICK,
ological Chemistry. (13 S.

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GRADUATE STUDENTS.

m Whittlesey Abbott, PH.B.,	*Worcester, Mass.*	257 Church st.
Dawson Adams, B.S., McGill University.	*Montreal,*	26 Trumbull st.
Prentiss Armsby, PH.B.,	*New Haven,*	206 York st.
Pomeroy Bartlett, PH.B.,	*New Britain,*	16 S. H.
Luis Blackmore, PH.B.,	*City of Mexico, Mexico,*	40 Park st.
s Marcus Blakslee, PH.B., Madison University.	*Hamilton, N. Y.*	14 Compton st.
r Linsley Cowles, PH.B.,	*Wallingford,*	Wallingford.
ic Henry Crafts, M.A., Dartmouth College.	*Uncasville,*	35 High st.
ic Perkins Dewey, PH.B.,	*Hartford,*	87 Olive st.
m Ely, PH.B., wn University.	*Providence, R. I.*	35 Hillhouse av.
tus James Emery, PH.B.,	*Bangor, Me.*	675 Chapel st.
d Hopkins Jenkins, B.A.,	*New Haven,*	206 York st.
ı Frederick Klein, D.E.,	*New Haven,*	86 Nichols st.
r Lakes, B.A., d University, England.	*Golden, Col.*	92 High st.
kichi Matsui, PH.B., olumbia College.	*Tokio, Japan,*	59 Wall st.
Boyd Neal, B.A.,	*Bloomsburg, Pa.*	6 Library st.
l Lewis Penfield, PH.B.,	*Catskill, N. Y.*	14 S. H.
d Rathbun, ell University.	*Buffalo, N. Y.*	N. S. H.
Lawrence Ripley, B.A.,	*Andover, Mass.*	123 W.
d Hubbard Russell, PH.B.,	*New Haven,*	19 Wooster pl.
m Thompson Sedgwick, PH.B.,	*Farmington,*	14 S. H.
nin Thaw, B.A., tern Univ. of Pa.	*Pittsburgh, Pa.*	171 Crown st.
Trumbull, B.A.,	*Valparaiso, Chili,*	124 High st.
e Lemuel Wells, PH.B.,	*New Britain,*	47 N. S. H.
l W. Williston, B.B., ansas Agric. College.	*Manhattan, Kan.*	92 High st.
nd Beecher Wilson, PH.B.,	*Geneva, Ill.*	523 Chapel st.

GRADUATES, 26.

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SENIOR CLASS.

r Innis Allen,	*Auburn, N. Y.*	33 Prospect st.
Vashington Asher,	*New Haven,*	6 Orange st.
Montgomery Atwater,	*New Haven,*	161 George st.
l Terry Bacon,	*Norwich,*	247 Church st.
Eben Barney,	*New Haven,*	110 Olive st.
Frederick Hunter Bartlett,	*Buffalo, N. Y.*	156 York st.
Bidleman Bissell,	*Lakeville,*	156 York st.
Booth,	*South Kingston, R. I.*	17 Wooster pl.
James Comstock,	*Toledo, O.*	37 College st.
William Congdon,	*Brooklyn, N. Y.*	120 Crown st.
ward Cromwell,	*Cranford, N. J.*	156 York st.
Thompson Dodd,	*West Meriden,*	156 York st.
Dodge,	*Stamford,*	156 York st.
Clarence Egan,	*Chicago, Ill.*	36 Elm st.
Young Foote,	*New Haven,*	156 York st.
Norton Fowler,	*Agawam, Mass.*	147 York st.
rrier Gallagher,	*New Haven,*	21 Olive st.
Godfrey,	*Southport,*	156 York st.
anson Harrison,	*Indianapolis, Ind.*	117 w.
Valdo Hart,	*New Britain,*	33 Prospect st.
ndley Hibbard,	*Woodside, N. Y.*	134 College st.
llhouse,	*New Haven,*	3 Hillhouse av.
DeVilliers Hoard,	*Chicago, Ill.*	122 York st.
Perry Hull,	*Lebanon,*	128 High st.
vett,	*New York City,*	131 Temple st.
k Augustus Jones,	*Newark, N. J.*	156 York st.
ennis Lewis,	*Bridgeport,*	156 York st.
Walker Meeker,	*Chicago, Ill.*	131 Temple st.
Mitsukuri,	*Tokio, Japan,*	130 York st.
Delavan Nelson,	*New York City,*	55 Trumbull st.
Nordhoff,	*Alpine, N. J.*	73 w.
k Wallace Paramore,	*St. Louis, Mo.*	36 Elm st.
Wilson Patrick,	*Omaha, Nebr.*	79 York st.
Roorbach,	*New York City,*	104 Grove st.
Augustus Saunders,	*Newport, R. I.*	187 Temple st.
Seth Silsby,	*Seneca Falls, N. Y.*	36 Elm st.
enry Skeel,	*Newburgh, N. Y.*	156 York st.
Eugene Smith,	*Hartford,*	187 Temple st.
s Henry Spencer,	*Suffield,*	147 York st.
Kidder Stetson,	*Bangor, Me.*	156 York st.
Eddie Stone,	*Cleveland, O.*	136 Crown st.
Stoddard Van Voorhis,	*New York City,*	55 Trumbull st.
homas Waring,	*Yonkers, N. Y.*	136 Crown st.
Lowery Webster,	*Staten Island, N. Y.*	86 w.
Seward Wilcox,	*Painesville, O.*	145 York st.
Smith Williams,	*Evanston, Ill.*	36 Elm st.

SENIORS, 46.

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JUNIOR CLASS.

Sidney Appleton,	*New York City,*	55 Trumbull st.
s Ketchum Averill,	*Bridgeport,*	128 High st.
s Rufus Ayres,	*Woodmont,*	156 York st.
s Backus Ball,	*New Britain,*	32 Mansfield st.
ı Clark Ballard,	*Louisville, Ky.*	132 College st.
d Hallaran Booth,	*New Orleans, La.*	25 Prospect st.
Banning Bradford,	*Wilmington, Del.*	60 w.
Osborn Carrington,	*New Haven,*	527 Chapel st.
Arthur Chanute,	*New York City,*	58 w.
ı Huntington Clark,	*Norwich,*	19 Trumbull st.
Baylies Coffin,	*Edgartown, Mass.*	167 Temple st.
d Allen Colby,	*St. Johnsbury, Vt.*	7 Library st.
McAlpine Collin,	*Penn Yan, N. Y.*	27 Prospect st.
s Mabie Crouse,	*Syracuse, N. Y.*	36 Elm st.
s Edward Doolittle,	*Onarga, Ill.*	36 Elm st.
Edward Emery,	*Fair Haven,*	17 Crown st.
n Henry Fox,	*Washington, D. C.*	25 Prospect st.
ı Edward Goodspeed,	*East Haddam,*	22 Trumbull st.
Varren Hardenbergh,	*Jersey City, N. J.*	66 w.
l Higgins,	*Buffalo, N. Y.*	134 College st.
Maynard Higginson,	*Newburgh, N. Y.*	61 w.
Hitchcock,	*Cheshire,*	19 Trumbull st.
ıre Lanahan Hooper,	*Baltimore, Md.*	169 Temple st.
facrae Ingersoll,	*New Haven,*	85 Trumbull st.
Edward Jensen,	*Cleveland, O.*	64 High st.
Brown Lewis,	*Utica, N. Y.*	86 w.
Theophilus Liefeld,	*New Haven,*	36 Orchard st.
d Becker Lyon,	*New Haven,*	710 Chapel st.
Solon McCrea,	*Chicago, Ill.*	36 Elm st.
foorhead,	*Pittsburgh, Pa.*	165 Temple st.
ıgene Munger,	*Watertown,*	27 Prospect st.
d Butler Needham,	*Hartford,*	36 Elm st.
ic Adriance Osborn,	*New Haven,*	150 York st.
Benjamin Phelps, Jr.,	*Watertown, N. Y.*	36 Elm st.
t Porter,	*Hartford,*	14 Lock st.
Sheffield Porter,	*New Haven,*	38 Hillhouse av.
d Freeman Porter,	*Stowe, Vt.*	23 Prospect st.
d Vilette Reynolds,	*Chicago, Ill.*	104 Grove st.
McNeil Rogers,	*Central City, Col.*	58 w.
ı Bliss Rogers,	*Lexington, Mass.*	36 Elm st.
farion Rosenthal,	*Rochester, N. Y.*	35 Howe st.
d Ruppert Sargent,	*New Haven,*	51 Elm st.
n Bartlett Schofield,	*West Point, N. Y.*	48 College st.
Starkweather,	*New Haven,*	178 Oak st.
Joseph Stoddard,	*Seymour,*	52 Whalley av.

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Adrian Rowe Wadsworth,	*Farmington*,	165 Temple st.
William Candee Warren,	*Buffalo, N. Y.*	61 w.
Adolph Frederic Wehner,	*New Haven*,	544 Chapel st
George Goodwin Williams,	*Glastonbury*,	60 w.
Arthur Burnham Woodford,	*West Winsted*,	116 College st.

JUNIORS, 50.

FRESHMAN CLASS.

Charles Francis Adams,	*Jessups, Md.*	87 Olive st.
Ethan Allen Andrews,	*Tarrytown, N. Y.*	Elm st.
George Jackson Angell,	*Brooklyn, N. Y.*	167 Temple st.
Edward Bailey,	*Harrisburgh, Pa.*	432 Chapel st.
Arthur Dean Bevan,	*Chicago, Ill.*	43 College st.
Frank Lewis Bigelow,	*New Haven*,	278 Orange st.
George Frederick Bosworth,	*Milford*,	518 State st.
Seymour Perry Bradley,	*Westville*,	Elm st., Westville.
Lester Paige Breckenridge,	*Westfield, Mass.*	114 High st.
Charles Sheldon Burnham,	*Woodbridge*,	29 Prospect st.
Charles Monroe Carpenter, Jr.,	*Brooklyn, N. Y.*	123 Park st.
Frederick Casper,	*West Meriden*,	14 Olive st.
Charles Chamberlain,	*Brooklyn, N. Y.*	167 Temple st.
Howard Field Chappell,	*Chicago, Ill.*	43 College st.
George Strong Daniels,	*New York City*,	64 High st.
Harry Sprague Davidson,	*San Francisco, Cal.*	432 Chapel st.
John Devereux,	*Cleveland, O.*	257 Church st.
Charles Manville Downs,	*New Haven*,	92 Greene st.
Oliver Winchester Dye,	*New Haven*,	194 Prospect st.
John Slade Ely,	*New York City*,	59 w.
George Sherman Folsom,	*Northford*,	161 George st.
Seymour Francis Frasick,	*Hartford*,	99 Wall st.
Albert Moses Gerstle,	*Youngstown, O.*	6 Orange st.
William Creighton Giles,	*Southport*,	84 Wall st.
Henry Holbrook Gladding,	*New Haven*,	90 Dwight st.
Edward Leeds Goodsell,	*New Haven*,	6 High st.
William Loomis Griswold,	*Banksville*,	127 Whalley av.
Frederic Jonathan Hiller,	*Cohoes, N. Y.*	59 w.
Edwin Augustus Hotchkiss,	*New Haven*,	69 York st.
Frank Allison Hubbard,	*Sandusky, O.*	123 Park st.
Blain Jamison,	*New Orleans, La.*	165 Temple st.
William Fowler Jarvis, Jr.,	*New York City*,	132 College st.
Jeme Tien Yow,	*Canton, China*,	136 College st.
James Eliphalet Killam,	*New Haven*,	67 Wooster st.
Edmund Parker Lord,	*Saxonville, Mass.*	134 College st.
Nathaniel White Lynde,	*West Brookfield, Mass.*	87 Olive st.
Silas Metzger,	*New Haven*,	17 Grove st.

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ıand Morse,	*Poland, O.*	A.
y Munn,	*Southington,*	127 Whalley av.
ɔtt,	*Corning, N. Y.*	134 College st.
ng,	*Canton, China,*	136 College st.
yvesant Peabody,	*Chicago, Ill.*	84 Wall st.
ɔs,	*Canandaigua, N. Y.*	123 Park st.
ı Pope,	*Jersey City, N. J.*	196 Crown st.
d Reed,	*Albany, N. Y.*	55 Trumbull st.
ɔxander Righter,	*Newark, N. J.*	8 Lock st.
inson Robinson,	*Lake Village, Ark.*	126 Crown st.
is Sargent,	*New Haven,*	51 Elm st.
ny Sargent,	*New Haven,*	51 Elm st.
Schiller,	*New Haven,*	8 Martin st.
eph Shanley,	*New Haven,*	211 Franklin st.
ıstus Smith,	*New Haven,*	36 Lyon st.
ard Stevens,	*New Haven,*	7 Wooster pl.
r,	*New York City,*	140 Edwards st.
ry Todd,	*Wallingford,*	22 Trumbull st.
ard Trumbull,	*Talcahuana, Chili,*	13 Trumbull st.
isay Trumbull,	*Talcahuana, Chili,*	13 Trumbull st.
Ullrich,	*Decatur, Ill.*	c. Davenport av. Asylum.
ıRensselaer,	*Albany, N. Y.*	23 Prospect st.
es Warner,	*West Suffield,*	305 Orange st.
iam Watson,	*Ashtabula, O.*	257 Church st.
Witbeck,	*Chicago, Ill.*	84 Wall st.
ɔker Wood,	*Morristown, N. J.*	191 Temple st.
ın Wright,	*Cromwell,*	88 Grove st.

FRESHMEN, 64.

IAL STUDENTS NOT CANDIDATES FOR A DEGREE.

n Bail,	*New Haven,*	43 Park st
heller,	*Boston, Mass.*	68 Whitney av.
ıry Chappell,	*Chicago, Ill.*	43 College st.
ırr Clemmons,	*New Haven,*	162 Putnam st.
lin Conway,	*New Haven,*	117 Washington st.
ınd Doolittle,	*Cheshire,*	22 Trumbull st.
well Earle,	*New Haven,*	214 Orchard st.
ır Smith,	*Honesdale, Pa.*	29 High st.
n Vechten,	*Albany, N. Y.*	55 Trumbull st.
ɔn,	*Northampton, Mass.*	90 Grove st.
ɔxson Whittlesey,	*New Haven,*	524 Chapel st.

SPECIAL STUDENTS, 11.

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SUMMARY.

Graduates. - - - - -	26
Seniors, - - - - -	46
Juniors, - - - - -	50
Freshmen, - - - - -	64
Special, - - - - -	11
Total, - - - -	197

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SHEFFIELD SCIENTIFIC SCHOOL

I.

OBJECTS.

E SHEFFIELD SCIENTIFIC SCHOOL is devoted to instr
esearches in the mathematical, physical, and natural sci
reference to the promotion and diffusion of science, an
e preparation of young men for such pursuits as r
ial proficiency in these departments of learning. It is
epartments of Yale College, like the law, medical, the
nd art schools, having its separate funds, buildings, tea
egulations, but governed by the Corporation of Yal
which appoints the professors and confers the degree
part, analogous to the academic department, or cl
e, and, in part, to the professional schools.
e instruction is intended for two classes of students:—
Graduates of this or of other Colleges, and other p
ied for advanced or special scientific study.
Undergraduates who desire a training chiefly mathem
cientific, in less part linguistic and literary, for higher
studies, or for various other occupations to which
ng is suited.

II.

HISTORY AND ORGANIZATION.

e School was commenced in 1847. In 1860, a conv
ing and a considerable endowment were given by Jose
eld, Esq., of New Haven, whose name, at the re
st of the Corporation of Yale College, was afte
ned to the foundation. Mr. Sheffield has since freq
nunificently increased his original gifts.
1863, by an act of the Connecticut Legislature, the na
for the promotion of scientific education (under the
onal enactment of July, 1862) was given to this depar
le College, which thus became "the College of Agric
he Mechanic Arts for Connecticut." Since that time
ially since the autumn of 1869, numerous liberal gifts

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been received from the citizens of New Haven, and from other gentlemen in Connecticut, New York, and St. Louis, for the endowment of the School, and the increase of its collections.

The action of the State led to the designation by law of a State Board of Visitors, consisting of the Governor, Lieutenant-Governor, three senior Senators, and the Secretary of the State Board of Education; and this Board, with the Secretary of the Scientific School, is also the Board for the appointment of students to hold the State scholarships.

At the request of the Governing Board, the Corporation of Yale College has also appointed a Board of Councillors for the School, consisting of a number of gentlemen who have taken a deep interest in its welfare.

The Governing Board consists of the President of Yale College and the Professors who are permanently attached to the School. There are several other instructors associated with them, a part of whom are connected with other departments of the College.

III.

BUILDING AND APPARATUS.

The two buildings in which the work of instruction in the Scientific School is mainly carried on are called Sheffield Hall and North Sheffield Hall; but instruction in Mineralogy, Geology, and Biology, including Zoology and Comparative Anatomy, is now given entirely in the Peabody Museum. These halls contain a large number of recitation and lecture rooms, a hall for public assemblies and lectures, chemical and metallurgical laboratories, a photographical room, an astronomical observatory, museums, a library and reading room, besides studies for some of the professors, where their private technical libraries are kept.

The following is a summary statement of the collections belonging to the School:

1. Laboratories and Apparatus in Chemistry, Metallurgy, Physics, Photography, and Zoölogy.
2. Metallurgical Museum of Ores, Furnace Products, etc.
3. Agricultural Museum of Soils, Fertilizers, useful and injurious insects, etc.
4. Collections in Zoölogy.
5. Astronomical Observatory, with an equatorial telescope by Clark and Sons of Cambridge, a meridian circle, etc.
6. A Collection of Mechanical Apparatus, constituting the "Collier Cabinet."

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dels in Architecture, Geometrical Drawing, Civil Engineering, Topographical ngineering, and Mechanics; diagrams adapted to public lectures; instruents for field practice.

ps and Charts, topographical, hydrographical, geological, etc.

erbarium of Professor Brewer, and the astronomical instruments of Prossor Lyman, are deposited in the buildings. Professor Eaton's herbarium, ear at hand, is freely accessible. Students also have access to the various boratories and collections in Natural Science in the Peabody Museum.

udents are also admitted, under varying conditions, to the ge and Society libraries, the College Reading Room, the ol of the Fine Arts, and the Gymnasium.

IV.

THE LIBRARY.

e special technical library of the Scientific School consists of five thousand volumes. Included in this is the "Hillhouse ematical Library" of twenty-four hundred volumes, collected g a long series of years by Dr. William Hillhouse, and in purchased and presented to the Institution by Mr. Sheffield. alogue of this collection forms a supplement to the Annual rt of the Governing Board for 1870. All the prominent sic journals of this country and of Europe, together with the edings of foreign academies, and of scientific societies, can be l either in this library or in the College Library to which nts have access.

V.

STRUCTION FOR GRADUATE AND SPECIAL STUDENTS.

rsons who have gone through undergraduate courses of study, or elsewhere, may avail themselves of the facilities of the ol for more special professional training in the physical sci- and their applications, gaining in one, two, or three years degree of BACHELOR OF PHILOSOPHY, or, in two additional of Engineering study, that of CIVIL ENGINEER, or of AMIC ENGINEER.

, engaging in studies of a less exclusively technical character, may become candidates for the degree of DOCTOR OF PHILOS-. The instruction in such cases will be adapted to the par- ar needs and capacities of each student, and may be combined that given by the graduate instructors in other departments

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of the University. This degree is conferred upon those who, having already taken a Bachelor's degree, engage as students in the Department of Philosophy and the Arts for not less than two years in assiduous and successful study. It is not given upon examination to those whose studies are pursued elsewhere. The requirements for it will in some cases exact of the student more than two years of post-graduate labor; so, especially, wherever the course of undergraduate study has been, as in the Scientific School, of less than four years. The candidate must pass a satisfactory final examination, and present a thesis giving evidence of high attainment in the branches of knowledge to which he has attended. A good knowledge of Latin, German and French will be required in all cases, unless, for some exceptional reason, the candidate be excused by the Faculty. The graduating fee is ten dollars.

Subjects likely to receive special attention are suggested as follows:—

Professor NORTON will instruct in applied mechanics and in spherical astronomy.

Professor LYMAN, in the use of meridional and other astronomical instruments, and in astronomical spectroscopy.

Professor DUBOIS, in the principles of thermodynamics, and utilization of heat as a source of power.

Professor BRUSH, in the analysis and determination of mineral species, and in descriptive mineralogy.

Professor JOHNSON, in theoretical, analytical, and agricultural chemistry.

Professor BREWER, in agriculture and forest culture, in the use of the microscope, and in physical geography.

Professor CLARK, in definite integrals, differential equations, analytical mechanics, the theory of numerical approximations, and the method of least squares.

Professor EATON, in structural and systematic botany, including the North American flora and the description of genera and species.

Professor MARSH, in palæontology and comparative osteology.

Professor WALKER, in public finance and in the statistics of industry.

Professor ALLEN, in analytical chemistry, and in metallurgy.

Professor VERRILL, and Professor SMITH, in zoölogy and geology.

The same courses of study are open, for a longer or shorter time,

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to graduate students who do not desire to become candidates for a degree.

Students who have taken the degree of Bachelor of Philosophy, may obtain the degree of CIVIL or of DYNAMIC ENGINEER at the end of two academical years, by pursuing the following higher course of study and professional training.

The course of study for the degree of CIVIL ENGINEER will comprise—

1. Higher Calculus. Higher Geometry. Theory of Numerical Operations.
2. Analytical Mechanics. Mechanics applied to Engineering.
3. A Course of Construction and Design. Projects.
4. Practical Astronomy, with use of instruments, computations, etc.

This course will occupy one year.

To secure the requisite amount of professional knowledge and practice, the candidate will be required to furnish a comprehensive report of the results of an examination into the existing condition of some special line of constructive art; or to present proper evidence that he has had actual charge in the field, for several months, of construction or surveying parties, or held some responsible position deemed equivalent to this.

An elaborate design must also be submitted of some projected work of construction, based upon exact data obtained from careful surveys made by the candidate, and comprising all the requisite calculations, and the necessary detailed drawings, and accompanied by full specifications of the work to be done, and the requirements to be met by the contractor.

The fee for this degree is five dollars.

The course of study for the degree of DYNAMIC ENGINEER will comprise

1. Higher Calculus. Higher Geometry. Theory of Numerical Operations.
2. General Principles of Dynamics (Analytical Mechanics), including special application of these principles to Dynamical problems.
3. Construction of Machines. Designs.
4. Preparation of theses on special subjects in Dynamic Engineering.

During the second year candidates will be permitted to employ such a portion of their time as may be deemed advisable or necessary in the examination of engineering works and manufacturing establishments, and may also have the privilege of entering upon professional practice, provided it is done with the knowledge and consent of the Professor of Dynamic Engineering, and under such circumstances as shall appear to him to be favorable to professional progress.

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An elaborate thesis on some professional subject, with an original design, or project, accompanied by proper working drawings, will be required at the end of the second year.

The fee for this degree is five dollars.

SPECIAL STUDENTS.—For the benefit of those who, being fully qualified, desire to pursue particular studies without reference to the obtaining of a degree, special or irregular students are received in most of the departments of the School; not, however, in the Select Course or in the Freshman Class.

It should be distinctly understood that these opportunities are not offered to persons who are incompetent to go on with regular courses, but are designed to aid those who, having received a sufficient preliminary education elsewhere, desire to increase their proficiency in special branches.

VI.

REQUIREMENTS FOR ADMISSION AND COURSES OF INSTRUCTION FOR UNDERGRADUATE STUDENTS.

TERMS OF ADMISSION.—Candidates must be not less than fifteen years of age, and must bring satisfactory testimonials of moral character from their former instructors or other responsible persons.

For admission to the Freshman Class the student must pass a thorough examination in the following subjects:

English—including grammar, spelling and composition. In grammar, Whitney's Essentials of English Grammar, or an equivalent.

History of the United States.

Geography.

Latin—six books of Cæsar's Commentaries, or their equivalent, and simple exercises in prose composition.

Arithmetic—including the metric system of weights and measures.

Algebra—so much as is contained in Loomis's Treatise, up to the general theory of equations.

Geometry—Plane, solid and spherical; including fundamental notions of symmetry, and examples of loci and of maxima and minima of plane figures:—an equivalent of the nine books of Chauvenet's Treatise, or to the ten books of Loomis's Elements and the Appendix, up to the section on Tranversals.

Trigonometry—including the analytical theory of the trigonometrical functions, and the usual formulæ; the construction and use of trigonometrical tables; and the solution of plane triangles;—so much, for example, as is contained in Wheeler's Plane Trigonometry (Boston, 1877), or Richards's Plane Trigonometry (New York, 1878).

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Candidates will be allowed the option of passing on the above-named subjects in two successive years. In such a case they must present themselves for examination at the June examination of the first year in the following subjects or parts of subjects: *History of the United States*, *Geography*, *Arithmetic*, *Plane Geometry*, and *Algebra to Quadratic Equations.*

In order to have this preliminary examination counted, candidates must pass satisfactorily on *all* the subjects; and notice must be given of the intention to divide the examination to Professor G. J. Brush, Executive officer of the School, on or before June 15.

In his preparation in GEOMETRY the candidate should, as far as practicable, have suitable exercises in proving simple theorems and solving simple problems for himself. It is important, too, that he should be accustomed to the numerical application of geometric principles, and especially to the prompt recollection and use of the elementary formulæ of mensuration. In TRIGONOMETRY he should be exercised in applying the usual formulæ to a variety of simple reductions and transformations, including the solution of trigonometrical equations. Readiness and accuracy in trigonometrical calculations are also of prime importance to the candidate. If the use of Logarithms is postponed in his preparation till Trigonometry is taken up (which is by no means necessary or advisable), he should then have abundant applications of them to all forms of calculation occurring in ordinary practice, as well as to those appearing in the solution of triangles. Finally, in all of his calculations, he should study the art of neat, orderly, and readily intelligible arrangement.

In LATIN, in order to secure the attainment of the required proficiency, the student should have such continued training in parsing as shall make him thoroughly familiar with declensions and conjugations, and accurate and ready in the application of the rules of syntax. As an additional guarantee of the proper mastery of these grammatical elements, the requirement has been adopted of "simple exercises in prose composition." By this is meant, merely, such a course of elementary exercises in translation, orally and in writing, from English into Latin as, in connection with the systematic parsing just mentioned, shall necessitate a familiarity with grammatical forms and the leading principles of syntax, and thus render the reading of the six books of Cæsar (or their equivalent) more thorough and fruitful. Since this course of elementary exercises in translation is designed as a preparation for reading, and not as a sequel to it, it should be invariably begun at the earliest stage of the study of Latin. To avoid any misapprehension of the nature of the extent of the requirement, the following works are specifically named, among which the candidate for examination may make his own selection. These are Harkness' "Introduction to Latin Composition," 112 pages; Leighton's "Latin Lessons," 91 pages; Smith's "Principia Latina," Part I.; or McClintock's "First Latin Book," 83 lessons (193 pp.). Any equivalent of these may be offered from the many useful books of a similar character. A knowledge of Prosody is not required.

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The examinations for admission take place at North Sheffield Hall, on Friday and Saturday, June 27, 28, and on Tuesday and Wednesday, September 9, 10, 1879. Opportunities for private examinations may, in exceptional cases, be given at other times.

In 1879, examinations, for the Freshman Class only, will also be held in Chicago and in Cincinnati (beginning on Friday, June 27, at 9 A. M.), at a place to be announced in the local newspapers of the day previous.

Candidates for advanced standing in the undergraduate classes are examined, in addition to the preparatory studies, in those already pursued by the class they wish to enter. No one can be admitted as a candidate for a degree, later than at the beginning of the Senior year.

THE COURSES OF INSTRUCTION, occupying three years, are arranged to suit the requirements of various classes of students. The first year's work is the same for all; for the last two years the instruction is chiefly arranged in special courses. The special courses most distinctly marked out are the following:—

(*a.*) In Chemistry;
(*b.*) In Civil Engineering;
(*c.*) In Dynamical (or Mechanical) Engineering;
(*d.*) In Agriculture;
(*e.*) In Natural History;
(*f.*) In Biology preparatory to Medical Studies;
(*g.*) In studies preparatory to Mining and Metallurgy;
(*h.*) In Select studies preparatory to other higher studies.

The arrangement of the studies is indicated in the annexed scheme.

FRESHMAN YEAR—INTRODUCTORY TO ALL THE COURSES.

FIRST TERM—*German*—Whitney's Grammar and Reader. *English*—Hadley's Brief History of the English Language; Exercises in Composition. *Mathematics*—Analytical Geometry. *Physics*—Atkinson's Ganot, with experimental lectures. *Chemistry*—Recitations and Laboratory practice. *Elementary Drawing*—Practical Lessons in the Art School.

SECOND TERM—*Language, Physics and Chemistry*—as stated above. *Mathematics*—Spherical Trigonometry (Wheeler's); Elements of Mechanics. *Physical Geography*—Lectures. *Botany*—Gray's Lessons, with Lectures. *Political Economy*—Elementary Lectures. *Drawing*—Elementary Projection Drawing; Isometric Drawing; Descriptive Geometry commenced.

For the Junior and Senior years the students select for themselves one of the following courses:—

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(a.) IN CHEMISTRY.

JUNIOR YEAR:

FIRST TERM—*Theoretical and Organic Chemistry.* Lectures. *Qualitative Analysis*—Fresenius. *Laboratory Practice. Blowpipe Analysis. German. French.*

SECOND TERM—*Laboratory Practice.* Quantitative Analysis. *Mineralogy*—Blowpipe Analysis and Determination of Species. Lectures. *French. German.*

SENIOR YEAR:

FIRST TERM—*Laboratory Practice*—Volumetric and Organic Analysis. *Geology*—Dana's. *Zoology*—Lectures and Excursions. *French.*

SECOND TERM—*Laboratory Practice*—Mineral Analysis and Assaying. *Agricultural Chemistry*—Recitations and Lectures (optional). *Geology*—Dana's Manual. *Metallurgy* (optional). *Mineralogy* (optional). *French.*

(b.) IN CIVIL ENGINEERING.

JUNIOR YEAR:

FIRST TERM—*Mathematics*—Elements of the Theory of Functions; Numerical Equations; Differential Calculus. *Surveying*—Field Operations. *Drawing*—Descriptive Geometry, continued, including Warped Surfaces. *German. French.*

SECOND TERM—*Mathematics*—Integral Calculus. Rational Mechanics. *Drawing*—Shadows, Perspective, and Gearing. Topographical. *Surveying*—Topographical. *German. French.*

SENIOR YEAR:

FIRST TERM—*Field Engineering*—Laying out Curves. Location of line of Railroad, with calculations of Excavation and Embankment. Hencks' Field Book for Railroad Engineers. *Civil Engineering*—Resistance of Materials. Bridges and Roofs commenced. Stone Cutting—with graphical problems. *Geology*—Dana's. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *French.*

SECOND TERM—*Civil Engineering*—Bridges and Roofs. Building Materials. Stability of Arches and Walls. Mahan's Civil Engineering. *Dynamics*—Principles of Mechaniam. Steam Engine. *Hydraulics*—Hydraulics and Hydraulic Motors. *Drawing*—Graphical Statics. *Astronomy*—Loomis's Astronomy, with practical problems. *Mineralogy*—continued. *Geology*—Dynamic. *French.*

(c.) IN DYNAMIC ENGINEERING.

JUNIOR YEAR:

FIRST TERM—*Mathematics*—Elements of the Theory of Functions; Numerical Equations; Differential Calculus. *Surveying*—Field Operations. *Drawing*—Descriptive Geometry, continued, including Warped Surfaces. *German. French.*

SECOND TERM—*Mathematics*—Integral Calculus. Rational Mechanics. *Drawing*—Shadows, Perspective, and Gearing. General Theory of Motion, and Principles of Mechanism. *German. French.*

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SENIOR YEAR:

T TERM—Principles of Mechanism. Applications of the Principles of ıism to Machinery. Machine Construction. Blowpipe Analysis. Resist- f Materials. Construction of roof trusses, girders, and iron bridges. ıe Drawing. *Geology. French.*

ND TERM—General principles of Heat employed as a source of power. ınstruction of Steam Generators. Steam Engines. Hot Air Engines. Engines. Water Wheels. The Construction of Water Reservoirs, and ts. Measurement of Water Supply. Discharge of Pipes, etc. Graphical Machine Designing. *Metallurgy.*

(d.) IN AGRICULTURE.

JUNIOR YEAR:

T TERM — *Theoretical and Organic Chemistry* — Lectures. *Qualitative is*—Fresenius. *Laboratory Practice. Blowpipe Analysis. German. French.*

ND TERM — *Laboratory Practice*— Quantitative Analysis. *Mineralogy*— pe Analysis and Determination of Species. *Physical Geography*—Lectures. —Lectures. *French. German.*

SENIOR YEAR:

T TERM—*Agriculture*—Cultivation of the Staple Crops of the Northern Tree Planting and Forestry. *Agricultural Chemistry* — Johnson's. *logy*—Huxley's. *Geology*—Dana's. *Zoology. English. French.*

ND TERM—*Agriculture*—Laws of Heredity and Principles of Breeding. ıs. *Geology* — Dana's. *Rural Economy* — History of Agriculture and ıs of Husbandry in Foreign Countries. Systems of Husbandry. *Agricul- hemistry*—Johnson's. *Geology*—Dana's. *Zoology. Botany. Microscopy.* . *French.*

(e.) IN NATURAL HISTORY.

er Geology, Mineralogy, Zoology, or Botany, may be made the principal some attention in each case being directed to the other three branches of l History.

JUNIOR YEAR:

T TERM—*Chemistry*—Qualitative Analysis. Laboratory Practice. Recita- *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *Botany* 's Manual; Use of the Microscope. *German. French.*

ND TERM—*Zoology*—Laboratory Practice. Excursions (land and marine). —Laboratory Practice. Thomé's Text-book. Excursions. *Mineralogy*— ed. *Physical Geography. German. French.*

SENIOR YEAR:

T TERM—*Geology*—Dana's. Excursions. *Zoology*—Laboratory Practice. s. Excursions. *Botany*—Herbarium Studies. Excursions. *Physiology* ey's. *French.*

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SECOND TERM—*Geology*—Dana's. *Anatomy of Vertebrates*—Huxley's. *Zoology*—Laboratory Practice. Lectures. *Botany*—Herbarium Studies, especially in the Cryptogamous Orders. Botanical Literature. Essays in Descriptive Botany. *Meteorology. French.*

Besides the regular courses of recitations and lectures on structural and systematic Zoology and Botany, and on special subjects, students are taught to prepare, arrange, and identify collections, to make dissections, to pursue original investigations, and to describe genera and species in the language of science. For these purposes, large collections in Zoology and Palæontology belonging to the College are available, as are also the private botanical collections of Professor Eaton.

(f.) IN BIOLOGY—PREPARATORY TO MEDICAL STUDIES.

During the Junior year, the work of this course is chiefly under the direction of the instructors in Chemistry. Especial attention is given to qualitative and quantitative analysis, in their physiological and medical bearings; and to the preparation and study of the organic proximate elements. In Toxicology the organic and mineral poisons are carefully studied. The special studies of the Senior year are wholly biological, particular attention being paid to the elements of comparative anatomy, histology, and physiology, to structural and physiological botany, and to systematic zoology. Instruction is also given in embryology, the laws of heredity, and human parasites. The order of studies is as follows:

JUNIOR YEAR:

FIRST TERM—*Chemistry*—Qualitative Analysis—Fresenius'. Laboratory Practice. Recitations. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *German. French.*

SECOND TERM—*Physiological Chemistry*—Klein's Handbook. *Toxicology*—Fresenius'. Laboratory Practice. Recitations. Lectures. *Botany* — Lectures, Practical Exercises in Phenogamous Plants, and Excursions. *Mineralogy*—continued. *German. French.*

SENIOR YEAR:

FIRST TERM — *Comparative Anatomy and Histology* — Laboratory Practice. *Physiology*—Huxley's, with Practical Exercises. *Botany*—Practical Exercises, Lectures and Excursions. *Geology*—Dana's Manual. *Zoology*—Lectures and Excursions. *French.*

SECOND TERM—*Comparative Anatomy and Histology*—Laboratory Practice and Recitations. *Botany* — Lectures. Laboratory Practice in Cryptogamia, etc. *Geology*—Dana's Manual. *Zoology*—Lectures. *Laws of Heredity and Principles of Breeding*—Lectures. *French.*

(g.) IN STUDIES PREPARATORY TO MINING AND METALLURGY.

Young men desiring to become Mining Engineers, can pursue the regular course in Civil or Mechanical Engineering, and at its close can spend a fourth year in the study of metallurgical chemistry, mineralogy, etc.

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(h.) IN SELECT STUDIES PREPARATORY TO OTHER HIGHER STUDIES.

JUNIOR YEAR:

FIRST TERM—*Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *Astronomy*. *English*—Early English. *History*—Freeman's Outlines. *French*. *German*.

SECOND TERM—*Mineralogy*—Lectures. *Physical Geography*—Guyot. Lectures. *Botany*—Lectures and Excursions and Laboratory Practice. *English*—Chaucer, Bacon, Shakespeare. *History*—Freeman's Outlines, with Lectures. *Political Economy*—Rogers's Manual. *German*. *French*.

SENIOR YEAR:

FIRST TERM—*Geology*—Recitations and Excursions. *Zoology*—Lectures and Excursions. *Linguistics*—Whitney's Life and Growth of Language. *English*—Shakespeare. *History*—Constitutional History of the United States. Lectures. *Political Economy*—Lectures. *French*.

SECOND TERM—*Geology*—continued. *Meteorology*—Lectures. *Political Economy*—Lectures. *English*—Shakespeare, Milton, Dryden, Pope, and later authors. *History*—Political History of United States. History of Europe from 1848. Lectures. *French*.

Exercises in English Composition are required during the entire course from all the students. The preparation of graduating theses is among the duties of the Senior Year.

Lectures on Military Science and Tactics are annually given.

DRAWING.—The course in drawing extends through the three years. During the first term of Freshman year, the students practice free-hand drawing at the Art School building, under the direction of Professor Niemeyer, of the Yale School of the Fine Arts. After the completion of the course in free-hand drawing, instruction is given by Mr. F. R. Honey, during the second term, in the elementary principles of instrumental drawing, embracing Elementary projection drawing, Isometric drawing, and Descriptive Geometry as far as Warped Surfaces. This course is obligatory upon all.

During the Junior and Senior years, instruction in drawing is obligatory only on the students in Civil and Mechanical Engineering. In the former year the system of instruction embraces shades and shadows, tinting, perspective, and warped surfaces. By this method all the problems in Descriptive Geometry are required to be worked out on the drawing-board instead of the

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black-board. The course extends through the entire year, and is under the direction of Mr. Honey.

In Senior year, students are required to apply the principles of drawing already obtained to works of construction, under the general supervision of the Professors of Civil and of Dynamic Engineering.

VII.

METHODS OF INSTRUCTION.

The instruction of this institution is given chiefly in small class rooms, in connection with recitations and by familiar lectures, illustrated by the apparatus at the command of the various teachers. In many studies weekly excursions are made for the purpose of collecting specimens and examining natural phenomena.

In Chemistry and Metallurgy the students work several hours daily in well-appointed laboratories, under the direct superintendence of the instructors, and are guided through systematic courses of quantitative and qualitative analysis, assaying, and the blow-pipe determination of minerals and ores.

In Botany, during the summer of Junior year, exercises in analyzing and identifying plants occur two or three times a week, followed by practice in writing characters and descriptions of plants from living specimens. Students are shown also the best methods of collecting and preserving for future study, specimens of Flowering Plants, Ferns, Mosses, Algæ, etc. In the autumn term of Senior year the work of the summer is continued. Students are encouraged to pursue special lines of Botanical investigation, and varied assistance is rendered them according to their needs. The final examination is intended to show what they have learned, and the collections they have made are considered to be of minor importance.

In Zoology weekly excursions are made during the third term of Junior and first term of Senior year, in company with the instructors, for the purpose of observing the habits and making collections of marine, fresh-water, and terrestrial animals of all classes. Each student is required to prepare and present for examination a collection containing a specified number of species, and illustrating the various classes of animals. He must also be able to pass an examination upon his collection, at least to the extent of explaining the classes and orders illustrated, and showing why particular specimens belong to the respective classes.

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In Geology excursions are made for the purpose of examining geological phenomena and making special collections of rocks and minerals. Each student is required to pass a satisfactory examination on his collections at the end of the first term of Senior year.

In addition to the above, a course of lectures is given every winter by the professors of the schools and others, on topics of popular interest.

VIII.

TUITION CHARGES.

The charge for tuition is $150 per year, payable, $55 at the beginning of the first and of the second term, and $40 at the middle of the second term. The special student of Chemistry has an additional charge of $70 per annum for chemicals and use of apparatus. He also supplies himself at his own expense with gas, flasks, crucibles, etc., the cost of which should not exceed $10 per term. A fee of $5 is charged members of the Freshman Class for chemicals and materials used in their laboratory practice, and the same fee is required from all who take the practical exercises in Blow-pipe Analysis and Determinative Mineralogy. A fee of $5 a term will also be charged to the students in the Zoological Laboratory, for materials and use of instruments. An additional charge of $5 is annually made to each student for the use of the College Reading Room and Gymnasium.

IX.

CHURCH SITTINGS.

Free sittings for students in this department of Yale College are provided as follows: in the Center Church (Cong.); in the Trinity Church (Epis.); and in the First Methodist Church.

Those who prefer to pay for a sitting for a year, more or less, in the churches above mentioned, or in any other church of any denomination, will be aided on application to the Secretary of School.

Sittings in the Gallery of the College Chapel are free as heretofore to the students of this department.

X.

DEGREES.

Students of this department, on the recommendation of the Governing Board, are admitted by the Corporation of Yale College to the following degrees. They are thus conferred:

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1. BACHELOR OF PHILOSOPHY: on those who complete any of the three-years courses of study, passing all the examinations in a satisfactory manner, and presenting a graduation thesis.

The fee for graduation as Bachelor of Philosophy, including the fee for Triennial Catalogues, Commencement Dinners, etc., is $10; unless the person taking the degree is also an academical graduate, when it is but $5.

2. CIVIL ENGINEER and DYNAMICAL ENGINEER: The requirements for these degrees are stated on pages 17–18.

3. DOCTOR OF PHILOSOPHY: The requirements for this degree are stated on page 16.

XI.

TERMS AND VACATIONS.

The next academic year begins Thursday, September 11, 1879. The first term begins eleven weeks from Commencement-day and continues fourteen weeks: the second term begins on the second Thursday in January and continues until Commencement-day, with a Spring recess—usually of eight days—including Easter. (See Calendar, p. 2.)

XII.

ANNOUNCEMENT IN RESPECT TO STATE STUDENTS.

The scholarships established in this School in consequence of the bestowal upon it of the Congressional grants are designed to aid young men who are in need of pecuniary assistance in fitting themselves for agricultural and mechanical pursuits of life. All applicants must be citizens of Connecticut. In case there are more applicants than vacancies, candidates will be preferred who have lost a parent in the military or naval service of the United States, and next to these such as are most in need of pecuniary assistance; and the appointments will be distributed as far as practicable among the several counties in proportion to their population. The Appointing Board for the current year, consisting of the Board of Visitors of the State and the Secretary of the School, will meet on June 24th, 1879, and at or about the same time in the year 1880, due notice of which will be given by publication in every county of the State. All applications should be made previous to that time. Blank forms for application will be sent, when requested, by Professor GEORGE J. BRUSH, Secretary of the Appointing Board.

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XIII.

ANNIVERSARY.

sary of the School is held on Tuesday of the Com-
k in Yale College, when selections from the grad-
re publicly read. The degrees are publicly con-
President and Fellows of Yale College on Com-
r.

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FOURTEENTH ANNUAL REPORT

OF THE

SHEFFIELD SCIENTIFIC SCHOOL

OF

YALE COLLEGE,

1879-80.

PRINTED BY ORDER OF THE GENERAL ASSEMBLY.

NEW HAVEN:
TUTTLE, MOREHOUSE & TAYLOR, PRINTERS.
1880.

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State Board of Visitors.

CONSTITUTING, WITH THE SECRETARY OF THE SCHOOL, THE BOARD FOR THE APPOINTMENT OF STATE STUDENTS.

GOVERNOR.

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LIEUTENANT-GOVERNOR.

His Honor DAVID GALLUP, Plainfield.

STATE SENATORS.

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Hon. LYMAN W. COE, Wolcottville.
Hon. FRANCIS L. DICKINSON, Vernon.

SECRETARY OF STATE BOARD OF EDUCATION.

Rev. BIRSEY GRANT NORTHROP, New Haven.

Councillors.

APPOINTED BY THE CORPORATION OF YALE COLLEGE.

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Hon. OLIVER F. WINCHESTER, New Haven.
JOSEPH E. SHEFFIELD, Esq., New Haven.
Prof. JAMES D. DANA, LL.D., New Haven.
HENRY FARNAM, Esq., New Haven.
M. DWIGHT COLLIER, M.A., St. Louis.
Hon. WILLIAM E. DODGE, New York City.

SECRETARY AND TREASURER OF THE SCHOOL.

GEORGE J. BRUSH.

JANITOR OF SHEFFIELD HALL.

ANTON PFEIFER, 55 Lock street.

JANITOR OF NORTH SHEFFIELD HALL.

GEORGE W. STODDARD, 407 Columbus street.

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REPORT

OF THE

STATE BOARD OF VISITORS.

To the General Assembly:

The State Board of Visitors of the Sheffield Scientific School herewith transmit the Annual Report of the Governing Board of that institution. This report, very full in details, will furnish all the particular information needed, and will also show the great usefulness of the educational work which the school is doing.

The greatly increasing interest in the study of the natural sciences, as well as the increasing disposition to pursue the higher technical parts of many branches of study, show that this school has done much to develop and to supply a most useful and important field of mental activity. The people of New England will never be likely to forget that there is a material value in education,—nor ought they to forget that the higher the education the more sure it is to bring returns of a pecuniary kind. In this respect the Scientific School is of great value. One or two illustrations will make this apparent.

The Agricultural Experiment Station and the instruction in chemistry, botany, geology, mineralogy and the allied sciences,

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gives to the farmer that specific learning by which farming is made successful and profitable. Instruction in Mechanical Engineering promotes and sharpens the inventive faculty—the faculty in which more than in any other Connecticut finds its material comfort and wealth. Many other examples will readily be suggested by an examination of the course of studies taught in this school.

We again call attention to the thirty free scholarships in the school which can be had for the asking. That there is not more competition for them is not creditable to the educational spirit of our young men.

By Order of the Board.

CHARLES B. ANDREWS,

Chairman.

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ANNUAL STATEMENT

OF THE

GOVERNING BOARD.

In presenting their Fourteenth Annual Report, the Governing Board wish to call attention to the instruction in Civil Engineering as carried on in the Sheffield Scientific School. With the reviving prosperity of the country this subject is beginning to assume once more the importance which belonged to it, before the general depression in business had brought about the cessation of any new enterprises demanding the services of a trained body of specialists. Under these circumstances, therefore, the Governing Board have deemed it expedient to give a brief account of the course in Civil Engineering as pursued here, and of the methods adopted to secure the results aimed at.

Course in Civil Engineering.

This Department was organized in the year 1852, under the title of the Yale School of Engineering, and under the direction of a Professor of Civil Engineering. The number of students in attendance, annually, since the date of organization, has varied from 15 to 50. At the opening of the School in 1852, there were but three other schools of Engineering in the United States. The number has since largely increased, and most of our Colleges and Universities have instituted Departments of Engineering; and yet, as a striking evidence of the important position this School of Engineering has occupied, it may be stated that, except in seasons of business depression, the number of students connected with it has generally increased from year to year—the maximum number having been reached in 1873. Periods of general depression in business, and especially in engineering enterprises, have had a marked influence on the size of our classes. The depression of 1857 was very sensibly felt; and that of the

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last few years has exercised a similar influence in this and all other departments of the Scientific School. We may reasonably expect that the revival of business activity, which has now begun, and especially of engineering operations, will materially increase the number of applicants for our course of Civil Engineering. But to reap the best results from the returning tide of prosperity, care must be taken that the strength and efficiency of the department be fully maintained, and that the advantages which have hitherto been held out be not diminished, but, on the contrary, augmented. This is rendered the more imperative by the largely increased provision that has been made for instruction in Engineering in other Institutions, and the ampler endowment of which other similar schools are now reaping the advantage. The general success of our graduates, and the evidence they have usually given of thoroughness of scientific attainment, and facility and accuracy in the use of field-instruments and in drawing, has been one prominent cause of the success of the department; and is the best evidence that the course of instruction is well adapted to secure the end desired. The graduates from the department have found occupation in many different lines of engineering practice. Several have been, for a number of years, assistants in the Coast Survey; others have done good service in the Western topographical surveys; many have engaged in general surveying and engineering, and a few in hydraulic engineering; some have become architects, after pursuing a special preparatory course; and others scientific instructors, or professors of engineering; but the larger number have engaged in railroad engineering, and found occupation in connection with the location, construction, or operation of railroads. In the year 1870 a separate department of Dynamic, or Mechanical Engineering was instituted, and a professor of dynamic engineering appointed. Since that date there have been separate classes, pursuing for the most part distinct courses of study, in Civil and Dynamic Engineering.

COURSE OF INSTRUCTION.

The field of practical Civil Engineering is of very wide extent; comprising various departments of construction, and the maintenance of existing structures, with the preliminary operations of location, and the different branches of surveying. The course of engineering is accordingly designed to fit the student to enter

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upon any of these several lines of professional practice. To do this effectually it must be a suitable combination of scientific theory with practical applications and field and office practice. It accordingly comprises a course of scientific studies, and another of practical exercises. The course of study need not here be detailed. The student starts from the vantage ground of a knowledge of the elementary Mathematics, and during the first two years is carried over the higher Mathematics, and theoretical Mechanics. He is thus fitted to take up in the third year the applications of mathematics and mechanics to the different departments of the science of construction. For reasons that will no doubt be sufficiently obvious, other studies not of a mathematical character are pursued, as Chemistry, Mineralogy and Geology; and the French and German languages occupy a certain portion of the allotted time. For the course of Geometrical Drawing the scientific foundation is laid in a knowledge of Descriptive Geometry; Graphical Statics and Constructional Drawing occupy a part of the Senior year. Practical Surveying comprises, besides the ordinary field operations with the compass and theodolite, and leveling, Topographical Surveying, with the use of the plane table, and the construction of topographical charts.

It is not supposed that a student who has completed the three years course, and taken the degree of Ph.B., is fitted to enter on the profession of Civil Engineering, and competent to take charge of engineering enterprises. The endorsement implied in the degree of C.E. is not given until after an additional year of higher study combined with practice in astronomical observation, and the designing of structures, and after a year or more of practical experience in responsible positions in the field.

APPARATUS AND INSTRUMENTS.

The department is supplied with a large collection of models and other illustrative apparatus, and with a complete set of instruments for practical surveying and field engineering. The models are of wood or plaster, and were imported from France and Germany. Many of them are designed to illustrate problems in Descriptive Geometry, and in Constructional Drawing. The collection also comprises numerous models, in plaster, of arches, spiral staircases, &c., and architectural models. The set of models and apparatus is by no means complete. There is need of additional models of bridges, roofs, &c., and especially of

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details of structures, and of testing machines. The only experimental apparatus on hand is a testing machine of moderate dimensions and limited application. This has proved very serviceable, and might, to great advantage, be supplemented by others of larger dimensions, and different adaptations.

Agricultural Experiment Station.

The Connecticut Agricultural Experiment Station has still the free and exclusive use of the first story of the eastern wing of Sheffield Hall, and as heretofore, the facilities of laboratory apparatus, and the materials of the school have also been used by the station when needed.

The New Haven Farmers' Club has had the free use of a room for its meetings, which are held on the first and third Fridays of the month for half the year, and on the first Friday of each month during the Summer. The New Haven County Agricultural Society has had the free use of rooms for its business meetings. In various other ways the school has, according to its opportunities, given such aid and assistance as it could to the farming and and gardening interests of the State.

Horological Bureau of Yale College.

The recent establishment of the Horological Bureau of the Winchester Observatory on the premises of the School affords, incidentally, increased advantages to students in Practical Astronomy, and although the Bureau does not belong to the School, it is in many ways so closely connected with its interests and work that some account of it seems appropriate in this report.

This Bureau is a department of the Winchester Observatory, and has been organized by the Board of Managers of the Observatory under the authority of the Corporation of Yale College, by whom the property of the Observatory is held. Dr. Leonard Waldo has been appointed the Astronomer in charge of the Bureau, and has the immediate direction of its affairs.

The work of the Bureau is twofold; first, to distribute by telegraph exact time-signals to cities, towns, railroads, factories, banks, jeweler's shops and other places, as may be required, for the purpose of securing correct and uniform time throughout a wide region; and secondly, to promote the growing and important industry of the clock and watch manufacture in this country by ample provision for the careful testing of time-pieces, as is

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done by several government observatories in behalf of the same industry abroad. This service, now introduced for the first time in this country, is explained in detail in the circular issued by the Bureau, which is printed at the end of this notice.

The standard of time adopted by the Bureau, (as well as by the College and the City of New Haven, and marked by the telegraphic time-signals sent to railroad offices and other places,) is that of the meridian of the New York City Hall, which is $4^m\ 19^s.58$ slower than that of New Haven, (meridian of the Observatory of the Bureau.)

For facilitating the work of the Bureau an Observatory has been erected on the lot of Mr. Sheffield next north of North Sheffield Hall, and on the same meridian as the Observatory of the Sheffield Scientific School, used by students in Practical Astronomy, the transit instrument of which is used as a collimator for the transit instrument of the Bureau, and *vice versa*. The latter instrument is a fine five-foot transit of four inches aperture by Troughton, which was presented to the College by Dr. William Hillhouse. The office and clock-room of the Bureau is in North Sheffield Hall, the eastern portion of the north room in the basement having been partitioned off, and rented to the Bureau for this purpose. In this room are the sidereal clock and chronograph by Bond for the transit observations, and the standard mean time clock and telegraphic apparatus for the distribution of the time-signals. The standard clock operates also another chronograph in the vaults of the Safe Deposit Company on Orange street, for rating the watches sent by the manufacturers, and there deposited for safe keeping.

The expenses of the Bureau are met by the receipts for the distribution of time-signals and rating time-pieces.

The relation of the work of the Bureau to the watch manufacture will be better understood from the following circular, which defines the conditions of certificates for rates.

Regulations governing the issue of certificates of Rates of Time-pieces.

This Bureau has been established by the Corporation of Yale College, at the recommendation of the Board of Managers of the Winchester Observatory, for the purpose of encouraging the higher development of the horological industries, and to pursue researches calculated to aid in the construction of refined apparatus for the measurement of Time. In order to gratify the expressed wish on the part of the makers for some proper provision for the rating of their time-pieces,

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the Board of Managers have made the necessary arrangements with the Safe Deposit Company of New Haven, for the erection within their steel vaults of the proper hot and cold closets, with appliances for controlling the moisture therein, and for the construction of the most recent forms of ordinary temperature closets. They have also provided for this work those appliances of modern astronomical science which can lessen the amount of personal errors or promise to render the service more exact.

The following regulations governing the reception of time-pieces and the issue of certificates of rates, have been adopted by the Board of Managers:

I. Classes of Certificates.

The following classes of certificates will be issued with time-pieces which have been deposited at this observatory for trial. The certificates will be signed by the Astronomer in charge of the Bureau, and will contain a detailed statement of the results obtained with each particular movement. In describing the positions of a movement the term "Dial up" indicates that the plane of the dial is horizontal and with the engraved side uppermost. "Dial vertical" indicates that the plane of the dial is vertical. The temperature of the refrigerator is approximately 40° F., that of the oven is approximately 90° F., and the ordinary temperature ranges between 65° and 75° F.

1. Class I includes those certificates issued with pocket chronometers or watches which have been subjected while rating to the following variations of position and temperature:

Dial up.	Twelve days at ordinary temperatures.
	One day in the refrigerator.
	One day in the oven.
Dial vertical.	Fourteen days pendant up.
	Two days pendant right.
	Two days pendant left.
Dial down.	Two days.
Dial up.	Eight days.

2. Class II includes those certificates issued with pocket chronometers or watches which have been subjected while rating to the following variations of position and temperature:

Dial up.	One day in the refrigerator.
	One day in the oven.
	Eight days at ordinary temperatures.
Dial vertical.	Eight days pendant up.
	Two days pendant right.
	Two days pendant left.

3. Class III includes those certificates issued with pocket chronometers or watches which have been subjected to the following variations of position:

Dial up.	One day in the refrigerator.
	One day in the oven.
	Eight days at ordinary temperatures.
Dial vertical.	Eight days at ordinary temperatures.

4. Class IV, Dial vertical, includes those certificates issued with pocket chronometers or watches which have been rated in the position

Dial vertical.	Twelve days at ordinary temperatures.

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5. Class V, Dial up, includes those certificates issued with pocket chronometers or watches which have been rated in the position

Dial up. Twelve days at ordinary temperatures.

6. Class A includes those certificates issued with box chronometers (sidereal or mean time) which have been rated for a minimum period of two months, and have been 24 hours in the oven and 24 hours in the refrigerator.

7. Class B includes those certificates issued with clocks which have been rated for a minimum period of three months at ordinary temperatures, and have been tested for compensation.

8. Class C includes those certificates issued with clocks which have been rated for a minimum period of six weeks at ordinary temperatures.

II. Conditions of issuing Certificates.

No certificates of the classes I, II, III, IV, A, will be issued in the following cases:

1. When the variation of rate with the dial vertical and pendant up in classes I, II, III, and in the positions indicated in classes A and IV, exceeds $2^s.0$ from one day to the following day.
2. When the variation of rate between the positions of "Dial up" and "Dial vertical" exceeds $10^s.0$.
3. When the variation for 1° F. exceeds $0^s.3$ between the ordinary temperature and the oven.
4. When the rate is greater than $10^s.0$ per day.

No certificate in the classes B or C will be issued in the following cases:

5. When the variation of rate from one day to the following day exceeds $1^s.0$, except there be a barometric variation as great as 0.7 inches.
6. When the variation for 2° F. exceeds $0^s.3$.

In the cases where no certificate is issued the movement will be returned to the maker with a statement of its performance.

III. Cost of Certificates.

For the purpose of enabling the Bureau to contribute to its own support as far as possible, the following charges will be made, payable on the notification that the certificates are ready to be issued in the particular cases.

For certificates of the Class I,	$3.00
For certificates of the Class II,	2.50
For certificates of the Class III,	2.00
For certificates of the Class IV,	1.00
For certificates of the Class A,	4.00

For classes B and C a charge will be made to cover the expense of mounting the clock upon the piers, and it will be necessary for persons desiring these certificates to confer, by letter, with the Astronomer in charge of the Bureau.

In the case of movements returned to the makers without certificates, a charge of five cents per day will be made for rating up to the time of such return.

IV. Miscellaneous.

1. All proper precautions will be taken by the Board of Managers against loss or injury by fire, theft or otherwise. The movements will be carefully guarded under the rules which govern the Safe Deposit Company. They will not be

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opened or in any way tampered with for any reason whatever; and they will not be handled, except by trained observers. If a movement should stop, it will be returned to the sender with an appropriate memorandum; but as it is manifestly inexpedient that a University Corporation should be responsible for loss or damage to property in its care for the purposes specified, it is to be understood that all risks are assumed by the persons who enter the time-pieces for certificates.

2. The Bureau will publish, in the annual report of the Astronomer in charge, the detailed rates of such time-pieces in the various classes as may seem to indicate the development of the horological art.

3. Blanks to be filled out in sending time-pieces to the Bureau will be furnished on application.

4. All movements will be wound immediately on their reception. When they have run down, however, the rating will not commence until they have been running again for five days. Unless requested otherwise, movements will be wound immediately previous to shipment from the Bureau.

5. The P. O. address of this department of the Observatory is Box 853, and time-pieces may be sent by special messenger or express directly to the safes at 89 Orange Street, New Haven, Conn. (The Adams Express Company occupy an adjoining office.)

LEONARD WALDO,
Astronomer in charge of the Horological Bureau.

Approved and ordered to be published by the Board of Managers of the Winchester Observatory.

C. S. LYMAN, *President.* H. A. NEWTON, *Secretary.*

New Haven, Conn., January 1, 1880.

The instrumental equipment of the Bureau is more fully exhibited in the list on the following page, furnished by the Astronomer in charge.

The certificates given for watch movements which have been tested according to the above regulations, state definitely the following particulars with respect to each, viz: mean daily rate, mean variation, variation for 1° Fahrenheit, difference before and after oven and refrigerator, difference between pendant up and dial up, difference between pendant up and pendant right, difference between pendant up and pendant left, difference between dial up and dial down, difference between first and last week, difference between the extremes of rate.

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No.	Instrument.	Makers.	Constants.	Remarks.
1	Transit.	Troughton & Simms, London.	Aperture 3.99 in. Focal length 5.1080 ft. Edge of the cube 8.00 in. Diameter of pivots 1.465 in. Value 1 div. of the level 0".930. Value 1 div. of the reticule 1s.495.	Provided with filar micrometer, reversing apparatus, fixed collimators and mounted on granite piers. Reticule of 25 lines by Rogers.
2, 3	Pair of collimators.	Wm. Grunow, New York.	Aperture 1.50 in. Focal length 17.0 in.	Reticules by Rogers.
4	Mean time standard clock.	E. Howard & Co., Boston. No. 191.	Dennison's 4-legged gravity escapement with jewelled pallets. The pendulum has a steel rod with mercurial compensation. Records the even seconds and the last 5 seconds of each minute, but omits the last 20 seconds of each 5 minutes.	An examination of the rates of this clock for a nine months trial at the Harvard College Observatory gives (Feb. to Oct., 1879) smallest mean daily rate —0s.159 (Mar.). Largest mean daily rate —0s.519 (Aug.), and the curve of rates follows the barometric curve.
5	Sidereal time stand'd clock.	William Bond & Son, Boston. No. 367.	Bond's 6-legged gravity escapement. The pendulum has mercurial compensation and steel rod. Records each second except the 59th second of each minute. Jewelled.	Mr. Hartnup of the Liverpool and Prof. Rogers of the Harvard College Observatory have had this clock at different times. Both observers found it an unusually excellent timepiece, the latter giving its extreme variation of rate as 0s.16 for seven months in 1868.
6	Sidereal clock.	Wm. Hillhouse, New Haven.	Dennison's 6-legged gravity escapement. The pendulum has a steel rod with mercurial compensation.	Constructing.
7	Sidereal box chronometer.	Poole, London. Resprung and adjusted by Negus.		Eight day chronometer.
8	Mean time pocket chronometer.	Johnson, London. No. 1436.		
9	Chronograph.	William Bond & Son, Boston. No. 313.	Bond's spring governor. Barrel 13.5 in. long and 6.0 in. diameter. Runs for 2h.5.	Regulated to sidereal time for transit observations.
10	Chronograph.	Alvan Clark & Sons, Cambridgeport.	Clark's conical pendulum governor. Barrel 14.1 in. long and 6.0 in. diameter. Runs for 2h.0	Regulated to mean time for the comparison of timepieces while rating.
11, 12	Repeating relays.	Chas. Williams, Jr., Boston.	Each 8 ohms resistance.	For repeating in three circuits simultaneously. For use with the clocks.
13–25	Telegraph sounders.	Chas. Williams, Jr., Boston.	Each 27 ohms resistance.	For use in distributing time signals on local circuits.
26–35	Thermometers.	Huddleston, Boston.	3 maxima, 3 minima, and 3 ordinary thermometers. Fahreheit's scale.	For use in the oven, refrigerator, and clock case.
36	Thermometer.	Casella, London. No. 29563.	Fahrenheit's scale.	Used as a standard. With Kew verification.
37	Mercurial barometer.	James Green, New York.		
38, 39	Compass galvanometers.	Chas. Williams, Jr., Boston.		For detecting induced currents and tracing telegraphic interruptions.
40	Apparatus for measuring the arc of vibration of a pendulum.	Wm. Grunow, New York.	Reads, for a seconds pendulum, to 5 seconds of arc.	Constructing.
41	Apparatus and closets for the testing of watch & chronome'r movements.	E. Howard & Co., Boston.	Capacity of refrigerator 100 movements. Capacity of oven 100 movements. Capacity of ordinary temperature closets 800 movements.	Refrigerator provided with zinc cases containing the movements surrounded by chemically dried air. Oven heated by coils of pipe through which hot water circulates.

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Public Lectures.

The thirteenth annual course of lectures to mechanics and others was given during the past year in the lecture room in North Sheffield Hall. The lecturers and the subjects are indicated in the following programme.

I.	Tuesday, Feb. 11.	—The Wallingford Tornado.	Prof. Brewer.
II.	Thursday, " 13.	—The Panic of 1837.	Prof. Sumner.
III.	Tuesday " 18.	—The Early History of the Steam Engine.	Prof. DuBois.
IV.	Thursday, " 20.	—Granite.	Mr. G. W. Hawes.
V.	Tuesday, " 25.	—Force and Design in Nature.	President Porter.
VI.	Thursday, " 27.	—Development of the Egg.	Prof. S. I. Smith.
VII.	Tuesday, Mar. 4.	—The Revision of the Authorized English Version of the New Testament.	Prof. Dwight.
VIII.	Thursday, " 6.	—Fundamental Principles of the Strength of Materials.	Prof. Norton.
IX.	Tuesday, " 11.	—The Total Solar Eclipse of July 29, 1878.	Prof. A. W. Wright.
X.	Thursday, " 13.	—The Form of the Law.	Prof. Johnson T. Platt.
XI.	Tuesday, " 18.	—The Principles of Taxation.	Prof. Walker.
XII.	Thursday, " 20.	—Canterbury Cathedral.	Prof. D. Cady Eaton.
XIII.	Tuesday, " 25.	—Trotting Horses.	Prof. Brewer.

Lectures on Military Science.

A course of lectures on military science, by officers of the U. S. Engineering School, at Willet's Point, was delivered in North Sheffield Hall as a part of the instruction in the school during the second term of the academic year 1878–79. The order and subjects of the lectures were as follows:

I.	Monday, Mar. 10.	—Strategy and Grand Tactics.	Lieut. G. McC. Derby, U. S. Engineers.
II.	Friday, " 14.	—Logistics.	Lieut. S. W. Roessler, U. S. Engineers.
III.	Monday, " 17.	—Small Arms and their influence on Tactics.	Lieut. W. M. Black, U. S. Engineers.
IV.	Friday, " 21.	—Artillery.	Lieut. J. B. Quinn, U. S. Engineers.
V.	Monday, " 24.	—Fortification.	Capt. A. M. Miller, U. S. Engineers.
VI.	Friday, " 28.	—Torpedoes.	General H. L. Abbot, U. S. Engineers.

Gifts.

To the department of Dynamic Engineering the following gifts have been made during the year:

Treatise on Machine Tools, Wm. Sellers & Co., 1877, Philadelphia.
Price Lists and Illustrated Catalogues, Eaton, Cole & Burnham Co., New York.
General Specifications for an Iron Railway Bridge at Derby, Conn., with drawings, from A. B. Hill, C.E., New Haven.

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"On the Loss of Heat by Radiation from Steam Boilers," and "Results of a Trial of a Steam Engine built by the J. C. Hoadley Co.," from J. C. Hoadley, Lawrence, Mass., also drawings.
Memoir of the Iron Bridge over the Missouri River at St. Joseph, Mo., by the Detroit Bridge and Iron Works.
Babcock and Wilcox Tubulous Steam Boilers, Descriptive Circulars and Drawings.
Working Bridge Drawings and Details from the Keystone Bridge Co.
Illustrated Album, Delaware Bridge Co.
Working Drawings of Bridges, Detroit Bridge and Iron Works.
Blank Specifications and Drawings from Milwaukee Bridge and Iron Works.
Set of drawings of boilers and boiler settings from Hartford Steam Boiler Inspection and Insurance Co.
Catalogues and Price Lists of Brown and Sharpe Manufacturing Co., Providence.
Descriptive Catalogue and Price List, W. & B. Douglas, Middletown, Conn.
Pocket Companion of useful Tables, etc., Carnegie Brothers & Co., Pittsburgh.
Illustrated Catalogue and Price List of Engineering Instruments from Young & Sons, Philadelphia, also same from Buff & Berger, Boston, from Heller & Brightley, Phila., W. & L. E. Gurley, N. Y., and Fauth & Co. Washington.
"The Methods of Testing Steam Engines," by George P. Hunt, Esq., U. S. Navy; dozen copies.
Illustrated Catalogue, George F. Blake Manufacturing Co.
Illustrated Catalogue, Rumsey & Co., Seneca Falls, N. Y.
Illustrated Catalogue, Morris Tasker & Co., Philadelphia.
"The Chemical Composition and physical properties of Steel Rails," by Charles B. Dudley, Ph.D.
Illustrated Price List, W. C. Duyckinck, New York.
Illustrated Catalogues, Ames Iron Works, N. Y.
Illustrated Catalogues, Providence Tool Co.
Illustrated Catalogues, Knowles Steam Pump Works.
Photographs of Milling machine, Nut facing machine, Cam Milling machines and Gear Cutter, Pratt & Whitney Co., Hartford.
Illustrated Circular of the Buckeye Automatic Cut-off Engine, from J. W. Thompson, Salem, O.

Case of Machine Cut Gears, Pratt & Whitney Co., Hartford.
Forms for Gear Cutters, in case, Pratt & Whitney Co., Hartford.
Set Taps and Dies, in case, Pratt & Whitney Co., Hartford.
Plain and Screw Guages, in Case, Pratt & Whitney Co., Hartford.
Model of Patent Movable Jib Crane, Pratt & Whitney Co., Hartford.

Additions to the Zoological Collections.

A. E. Verrill, Curator.

During the past year the most important additions to the collection have been made through the coöperation of the curator with Professor Baird, U. S. Commissioner of Fish and Fisheries.

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The curator, as in the eight preceding seasons, during the summer vacation took charge of the investigation of the marine invertebrata of the coast, in connection with the work of the Fish Commission, and the very large collection obtained by dredging off the eastern coast of Massachusetts was sent to the Museum to be elaborated and reported upon, and eventually to be in part distributed to other institutions. This collection filled about forty large cases, and included many thousands of specimens, mostly preserved in alcohol. Mr. Richard Rathbun has been employed by Professor Baird, during the present and past year, at the Museum, to aid the curator in working up the vast amount of material that has thus accumulated in our store-rooms. Mr. Rathbun and Mr. Sanderson Smith were associated with the curator during the summer, in making the collections, and after the curator returned, in September, they continued to carry on the dredging. Mr. Smith has also been engaged at the Museum since his return, in working upon the mollusca obtained during the past and previous seasons. The dredging was carried on, last summer, from Provincetown, Mass., on the U. S. Steamer "Speedwell," Lieut. Z. L. Tanner, Commander. Among others who took an active part in making these collections, Professor H. E. Webster, of Union College, should be particularly mentioned. Another very large and valuable collection, made for the U. S. Fish Commission by the fishermen of Gloucester, Mass., mostly from the deep fishing banks, off Nova Scotia, has also been sent here for elaboration. As fast as these collections are worked up, full series will be deposited in the Museum by the curator. From the Fish Commission we have also received a large and valuable series of the marine fishes of our northern coast, including many of the rare and recently discovered deep-water species. Mr. Rathbun has put up, under the supervision of the curator, fifty sets of duplicates from the Fish Commission collection of invertebrates, to be distributed to various other institutions. Half of these have already been sent away. During the first half of the year, Mr. E. B. Wilson acted as assistant. Subsequently, Miss Bush has been employed in completing the catalogues and writing labels. Mr. E. H. Hawley has, during the year, continued the work of mounting the specimens of shells and other invertebrates in the Museum. This work is so far advanced that all the cases are now filled, and many of them over-crowded with specimens which are, for the most part, permanently, handsomely, and con-

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veniently mounted and labelled. Large numbers of specimens, amounting to more than half of the collection, are still stored in the attic and basement, for want of case-room to exhibit them.

List of Additions.

S. W. Williston, leeches, crustacea, insects and mollusks from Lake Como, Wyoming.

Fred. Habersbaw, iguanoid lizard, Panama.

Edward S. Ely, Indian birds.

Geo. W. Potter, copper-head and living black snake, E. Haven.

Geo. B. Grinnell, parasites from trout.

J. B. Neal (S. S. S.), parasites from striped bass.

J. G. Durand, salamander (*Amblystoma punctatum*).

J. T. Mix, ruby-throated humming-bird.

Geological Survey of Canada (through J. F. Whiteaves), collection of corals and echinoderms from Queen Charlotte I., British Columbia; rare coral (*Paragor gia Pacifica* V.) from Vancouver Island, (dep. by A. E. Verrill). Collection of shells, from Queen Charlotte Island, in exchange.

A. H. Thompson, *Squilla empusa*, New Haven.

T. S. Gold, salamander (*Amblystoma punctatum*).

J. B. Bissell and W. H. Fox (S. S. S.), rare toads (*Scaphiopus Holbrookii*), New Haven.

E. C. Allen, skin of black snake.

H. R. Seward, water-snake.

F. S. Smith (S. S. S.), insects, skin of snake, skates, nest and eggs of blue-jay, New Haven.

C. C. Hickox, W. Haven, salt-marsh turtle (*Malacoclemmys palustris*).

A. E. Verrill, striped snake (*Eutœnia*), shells, sponges, annelids, insects, etc., New Haven. Lot of mounted birds, W. Medway, Mass., deposited.

E. B. Wilson (S. S. S.), striped snake (*Eutœnia*).

Thomas A. Bostwick, turtles (*Aromochelys odorata* and *Chrysemys*), New Haven. Black snake and striped snake, two puffing adders, Plainville, Conn. Red bat, with two young, New Haven.

Thomas Osborne (Y.C.), salamanders (*Amblystoma punctatum*).

F. A. Manning (Y. C.), living snake (*Eutœnia saurita*), New Haven.

Professor C. U. Shepard, Amherst College, unique type specimen of a starfish (*Goniaster Americanus* Verrill), from off Charleston, S. C.

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Rev. J. H. Hardy, New Haven, eggs of ring dove.

Miss Essie Shailer, Essex, Conn., eleven bats (*Vespertilio subulatus*), young and old, living.

Museum of Comparative Zoology, one of the original type specimens of *Funiculina Forbesii* Verrill, from Scotland.

George E. and A. H. Verrill, New Haven, box-turtle, painted turtles, and large frogs, living.

Horace Bowman, eye-balls of sword fish from off Block Island, collected by Capt. Chas. Smith.

Yale Medical Institute, a lizard, flying fishes, pipe-fish, monstrous chicken, lot of barnacles (*Anatifa*), localities not known; lot of crabs and shrimp from the Gulf Stream; chameleon, and locusts, locality unknown.

Sereno Thomas, New Haven, living painted turtle (*Chrysemys picta*) from New Haven.

F. W. Smith, box-turtle, living, from Woodbridge.

J. H. Osborn, M.D., Southington, Conn., a large living rattlesnake (*Crotalus horridus*), from Southington, taken by Mr. Newell, June, 1879.

Geological Survey of Canada, through J. F. Whiteaves. In exchange. A valuable lot of shells from Queen Charlotte Islands, collected by G. M. Dawson.

Professor D. P. Smith (Yale Med. Inst.), nest of humming bird, from East Windsor Hill, *Unio complanatus* from Connecticut River.

Virgil M. Dow, New Haven, lot of fishes, reptiles, arachnids, myriapods, insects, crustacea, etc., in alcohol, native and foreign, no localities given.

H. E. Smith (S.S.S.), injected preparations of leeches.

D. B. Lane, Monroe, two nests of hornets (*Vespa maculata*).

L. N. Bail (S.S.S.), three living black snakes (*Bascanion constrictor*).

George Bifield, New Haven, living puffing adder (*Heterodon platyrhinus*), New Haven.

G. M. Kimball, lot of young striped snakes (*Eutænia sirtalis*), taken from one adult female, Rangeley Lake, Maine.

Arthur L. Howard, New Haven, rock eel (*Murænoides mucronatus*).

Gilbert LaVere, E. Haven, living salamander (*Amblystoma opacum*).

James Gillin, New Haven, *Ascaris lumbricoides*.

David R. Alden (S.S.S.) cast skin of snake.

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C. M. Crouse (S.S.S.), living striped snake.

C. J. Rice, North Haven, living salamanders (*Desmognathus*).

Samuel Green, New Haven, young living alligator, from Florida.

H. B. Coffin (S.S.S.), salamander (*Amblystoma opacum*), New Haven.

C. Berns (Y. C.), living turtle "gopher" from Florida.

S. P. Willard (Y. C. 1878), striped snake, New Haven.

Adam Herman, New Haven, mounted skunk, from near New Haven (purchased).

Willis B. Franklin, New Haven, young living alligator, from Florida.

A. E. Verrill (deposited), lot of mounted birds from W. Medway, Mass., collected by C. A. Houghton. Marine invertebrates from Massachusetts Bay, collected by J. H. Emerton. Large series of invertebrata from coasts of New England, Nova Scotia and Newfoundland, from the U. S. Fish Commission. Annelids and other invertebrates, from Cape Cod, collected by Professor H. E. Webster.

Small collections of insects have been presented by E. H. Hawley, Mrs. E. A. Brown, Geo. W. Potter, J. Nettleton, G. J. Brush, Miss Tuttle.

Anniversary.

The Anniversary exercises were held in North Sheffield Hall on the evening of Tuesday, June 24, 1879. The candidates for degrees with the subjects of their graduation theses are given in the following schedule. Those marked with an asterisk were read in the evening.

Doctors of Philosophy. (3)

Henry Prentiss Armsby, Ph.B., *New Haven*. On the Determination of Albuminoids in Feeding Stuffs.

Edward Hopkins Jenkins, B.A., *New Haven*. An Examination of the Methods of Dumas, and of Varrentrapp and Will for Determining Nitrogen.

Bachelors of Philosophy. (40)

Harry Washington Asher (Select), *New Haven*. The Signal Service of the United States.

William Montgomery Atwater, (Select), *New Haven*. Obligation of the Citizen.

Nathaniel Terry Bacon (Civil Engineering), *Norwich*. Some Experiments on the Position of the Natural Axis in Bent Beams and their Results.

Samuel Eben Barney (Civil Engineering), *New Haven*. On the Removal of Tower and Crown Rocks in Boston Harbor.

George Frederick Hunter Bartlett (Select), *Buffalo, N. Y.* The Paper Money of the New England Colonies.

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MALCOM BOOTH (Dynamic Engineering), *South Kingston, R. I.* The Mechanical Equivalent of Heat.

* WILLIAM JAMES COMSTOCK (Chemistry), *Toledo, O.* The Gibbs Method for Separating Cerium from Lanthanum and Didymium.

ALBERT WILLIAM CONGDON (Civil Engineering), *Brooklyn, N. Y.* On Narrow Guage Railways.

JOHN HOWARD CROMWELL (Dynamic Engineering), *Cranford, N. J.* Plain toothed Gearing.

GEORGE CLARENCE EGAN (Biology), *Chicago, Ill.* History of the Discovery of the Circulation of the Blood.

EMERSON YOUNG FOOTE (Select), *New Haven.* A Review of Coöperation.

NORMAN NORTON FOWLER (Select), *Agawam, Mass.* The Interoceanic Ship Canal across the American Isthmus.

JOHN CURRIER GALLAGHER (Select), *New Haven.* The Objects of Arctic Exploration.

WILLIAM WESLEY GIBSON (Civil Engineering), *New Haven.* The Manufacture and Uses of Biton Aggloméré.

FRANK HANSON HARRISON (Biology), *Indianapolis, Ind.* The Glycogenic function of the Liver.

CHARLES DEVILLIERS HOARD (Select), *Chicago Ill.* The Absolute International Rights of States.

CHARLES PERRY HULL (Biology), *Lebanon.* The Circulatory System of *Amblystoma punctatum.*

JOHN JEWETT (Chemistry), *New York City.* On the influence of Acetic Acid in the separation of Iron as ferric acetate from other metals.

ALFRED DENNIS LEWIS (Select), *Bridgeport.* The Modern Glacier.

GEORGE WALKER MEEKER (Select), *Chicago, Ill.* Tariff Legislature on Iron.

* KAKICHI MITSUKURI (Zoology), *Tokio, Japan.* Anatomy of the common Gray Mussel (*Modiola plicatula* Lamark.)

* JAMES BOYD NEAL, B.A. (Biology), *Bloomsburg, Pa.* The Heart and Aortic Arches in Vertebrates.

EDWARD DELAVAN NELSON (Dynamic Engineering), *New York City.* The Screw Propeller.

* WALTER NORDHOFF (Agriculture), *Alpine, N. J.* Peasant Life in a German Village.

FREDERICK WALLACE PARAMORE (Select), *St. Louis, Mo.* English Occupation of Cyprus.

ROBERT WILSON PATRICK (Select), *Omaha, Nebr.* Transportation in the United States.

HAROLD ROORBACH (Select), *New York City.* The Physical Elements in American Republicanism.

* GEORGE AUGUSTUS SAUNDERS (Civil Engineering), *Newport, R. I.* Modern Turbines as represented by the Swain Turbine.

WILLIAM SETH SILSBY (Dynamic Engineering), *Seneca Falls, N. Y.* The Steam Fire Engine.

RUFUS HENRY SKEEL (Dynamic Engineering), *Newburgh, N. Y.* The Theory and Construction of the Speaking Telephone.

* HERBERT EUGENE SMITH (Biology), *Hartford.* Anatomy of the American Medicinal Leech.

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THADDEUS HENRY SPENCER (Dynamic Engineering), *Suffield.* History of the Locomotive.

ISAIAH KIDDER STETSON (Select), *Bangor, Me.* The Importance of the Preservation of Forests.

DANIEL EDDIE STONE (Chemistry), *Cleveland, O.* Methods for the determination of Phosphorus in Pig Iron.

ARTHUR STODDARD VAN VOORHIS (Select), *New York City.* The Chinese Question.

JOHN THOMAS WARING (Select), *Yonkers, N. Y.* Irrigation in India.

WALTER WATSON (Civil Engineering), *Northampton, Mass.* Design of a wrought iron Roof Truss of 200 feet span.

* ALBERT LOWREY WEBSTER (Civil Engineering), *Staten Island, N. Y.* Review of the Musconetcong Tunnel.

* CHARLES SEWARD WILCOX (Dynamic Engineering), *Painesville, O.* The Indicator and the Indicator Diagram.

* WALTER SMITH WILLIAMS (Select), *Evanston, Ill.* The Northeastern Fisheries.

PRIZES.

The following prizes were awarded during the year:

CLASS OF 1879.

For excellence in German, the prize awarded to NATHANIEL TERRY BACON, with honorable mention of ROBERT WILSON PATRICK.

For excellence in French, the prize awarded to GEORGE AUGUSTUS SAUNDERS.

For excellence in Civil Engineering, the prize awarded to GEORGE AUGUSTUS SAUNDERS.

CLASS OF 1880.

For excellence in the Mathematics of Junior Year, the prize awarded to DWIGHT PORTER, with honorable mention of EDWIN MCNEIL ROGERS and HARRY OSBORN CARRINGTON.

CLASS OF 1881.

For excellence in all the Studies of Freshman Year, the prize awarded to ETHAN ALLEN ANDREWS.

For excellence in Mathematics, the prize awarded to ETHAN ALLEN ANDREWS, TIEN YOW JEME and WILLIAM MEEKER WOOD.

For excellence in Physics, the prize awarded to ETHAN ALLEN ANDREWS.

For excellence in Mechanical Drawing, the first prizes awarded to JOHN SLADE ELY and SEYMOUR FRANCIS FRASICK; second prizes to ETHAN ALLEN ANDREWS, GEORGE FREDERICK BOSWORTH, LESTER PAIGE BRECKENRIDGE, CHARLES MANVILLE DOWNS, HENRY HOLBROOK GLADDING, and WILLIS BENTON WRIGHT.

For excellence in English Composition, first prizes awarded to SEYMOUR FRANCIS FRASICK and RICHARD LINDSAY TRUMBULL; second prizes to ETHAN ALLEN ANDREWS, and JOHN SLADE ELY; third prizes to ARTHUR DEAN BEVAN, GEORGE FREDERICK BOSWORTH, GEORGE SHERMAN FOLSOM, HENRY HOLBROOK GLADDING, HOWARD VAN RENSSELAER, and WILLIAM MEEKER WOOD.

CLASS OF 1882.

For the best Entrance Examination, the prize awarded to HARRY WEIR CASEY, *Washington, D. C.* Prepared at the Emerson Institute, Washington, D. C.

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PROGRAMME OF STUDIE

AND

CATALOGUE,

FOR THE COLLEGE YEAR 1879-80.

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CALENDAR.

1879.		
11 Sept.	Thursday,	First Term begins.
18 Dec.	Thursday,	First Term ends.
1880.		**Winter Vacation of three weeks.**
8 Jan.	Thursday,	Second Term begins.
17 March,	Wednesday,	Spring Recess of two weeks begins.
31 March,	Wednesday,	Spring Recess ends.
29 June,	Tuesday,	Meeting of Appointing Board.
29 June,	Tuesday,	Anniversary.
1 July,	Thursday,	Commencement.
2 July,	Friday,	Examination for Admission.
3 July,	Saturday,	
		Summer Vacation of eleven weeks.
14, 15 Sept.	Tues., Wedn.,	Examination for Admission.
16 Sept.	Thursday,	First Term begins.
23 Dec.	Thursday,	First Term ends.

ABBREVIATIONS.

S. H.	Sheffield Hall.
N. S. H.	North Sheffield Hall.
TR.	Treasury Building.
D.	Durfee College.
F.	Farnam College.
E.	East Divinity Hall.
W.	West Divinity Hall.
P. M.	Peabody Museum.

In the buildings belonging to the Sheffield Scientific School, the rooms numbered from 1 to 21 are in Sheffield Hall: from 26 to 58 in North Sheffield Hall.

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GOVERNING BOARD.

APPOINTED BY THE CORPORATION OF YALE COLLEGE.

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REV. NOAH PORTER, D.D., LL.D., (7 TR.) 31 Hillhouse av.

Chairman and Executive Officer.

GEORGE J. BRUSH, (3 S. H.) 14 Trumbull st.

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ARRANGED IN THE ORDER OF THEIR GRADUATION.

WILLIAM A. NORTON,
Civil Engineering. (34 N. S. H.) 72 Prospect st.

CHESTER S. LYMAN,
Physics and Astronomy, Theoretical and Practical. (39 N. S. H.) 88 Trumbull st.

WILLIAM D. WHITNEY,
Linguistics and French. (205 D.) 246 Church st.

GEORGE J. BRUSH,
Mineralogy. (3 S. H.) 14 Trumbull st.

SAMUEL W. JOHNSON,
Theoretical and Agricultural Chemistry. (12 S. H.) 54 Trumbull st.

WILLIAM H. BREWER,
Agriculture (NORTON *Professor*). (4 S. H.) 246 Orange st.

JOHN E. CLARK.
Mathematics. 29 Eld st.

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Botany. (41 N. S. H.) 70 Sachem st.

THOMAS R. LOUNSBURY,
English. 22 Lincoln st.

FRANCIS A. WALKER,
Political Economy and History. 68 Whitney av.

OSCAR D. ALLEN,
Analytical Chemistry and Metallurgy. (13 S. H.) 189 Temple st.

ADDISON E. VERRILL,
Zoölogy and Geology. (15 P. M.) 148 College st.

SIDNEY I. SMITH,
Comparative Anatomy. (14 P. M.) 148 College st.

WILLIAM G. MIXTER,
Chemistry. (8 S. H.) 8 Trumbull st.

A. JAY DUBOIS,
Dynamical Engineering (HIGGIN *Professor*). (45 N. S. H.) 328 Howard av.

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Free Hand Drawing. 8 Art School

FREDERICK R. HONEY,
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JOSEPH J. SKINNER,
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AUGUST H. EDGREN,
French. 79 York st.

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JAMES F. COLBY,
Political Economy. Room 10, 179 Church st.

ALLEN B. HOWE,
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RUSSELL H. CHITTENDEN,
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Mineralogy. 14 S. H.

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GRADUATE STUDENTS.

William Whittlesey Abbott, PH.B.	*New Haven,*	257 Church st.
Otis Elihu Atwater, B.A.	*Brattleboro, Vt.*	34 S. M.
Leonard Strong Austin, PH.B.	*Stratford,*	Stratford
John Pomeroy Bartlett, PH.B.	*New Britain,*	16 S. H.
Russell Henry Chittenden, PH.B.	*New Haven,*	95 Humphrey st.
William James Comstock, PH.B.	*Toledo, O.*	37 College st.
Henry Herbert Donaldson, B.A.	*Stockbridge, Mass.*	120 W.
Augustus James Emery, PH.B.	*Bangor, Me.*	544 Chapel st.
Henry Allen Hazen, M.A. Dartmouth College.	*New Haven,*	298 Chapel st.
Jefferson Engel Kershner, B.A. Franklin and Marshall College.	*Leesport, Pa.*	26 Trumbull st.
Joseph Frederick Klein, D.E.	*New Haven,*	86 Nichols st.
Benjamin Franklin Koons, B.A. Oberlin College.	*Sulphur Springs, O.*	36 Court st.
Charles Newton Little, B.A. Nebraska University.	*Lewis, Iowa,*	135 Elm st.
Samuel Lewis Penfield, PH.B.	*Catskill, N. Y.*	14 S. H.
Richard Rathbun, Cornell University.	*Buffalo, N. Y.*	60 Whalley av.
Frederick Sumner Smith, B.A.	*New Haven,*	78 Trumbull st.
Heman Bangs Smith, M.D.	*New Haven,*	102 Howe st.
Ebin Jennings Ward, PH.B.	*Marseilles, Ill.*	251 Church st.
Albert Lowry Webster, PH.B.	*Staten Island, N. Y.*	14 S. H.
Horace Lemuel Wells, PH.B.	*New Britain,*	14 S. H.
Samuel Wendell Williston, M.A. Kansas State Agric. College.	*Manhattan, Kan.*	162 Olive st
George Leverett Wilson, PH.B.	*West Killingly,*	47 N. S. H.

GRADUATE STUDENTS, 22.

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SENIOR CLASS.

Daniel Sidney Appleton, Jr.	*New York City,*	43 College st.
Charles Rufus Ayres,	*Woodmont,*	6½ York sq.
Charles Backus Ball,	*New Haven,*	32 Mansfield st.
Rogers Clark Ballard,	*Louisville, Ky.*	464 Chapel st.
Harry Banning Bradford,	*Wilmington, Del.*	36 Elm st.
Harry Osborn Carrington,	*New Haven,*	527 Chapel st.
Joseph Arthur Chanute,	*New York City,*	66 w.
George Huntington Clark,	*Norwich,*	19 Trumbull st.
Arthur Baylies Coffin,	*Edgartown, Mass.*	128 High st.
Edward Allen Colby,	*St. Johnsbury, Vt.*	7 Library st.
Frank McAlpine Collin,	*Penn Yan, N. Y.*	27 Prospect st.
Charles Mabie Crouse,	*Syracuse, N. Y.*	36 Elm st.
Charles Thompson Dodd,	*West Meriden,*	6½ York sq.
Arthur Dodge,	*Stamford,*	525 Chapel st.
Thomas Edward Doolittle,	*Onarga, Ill.*	36 Elm st.
Jacob Edward Emery,	*Fair Haven,*	17 Crown st.
George Edward Goodspeed,	*East Haddam,*	189 George st.
John Warren Hardenbergh,	*Jersey City, N. J.*	36 Elm st.
Louis Maynard Higginson,	*Newburgh, N. Y.*	43 College st.
Walter Hitchcock,	*Cheshire,*	19 Trumbull st.
Theodore Lanahan Hooper,	*Baltimore, Md.*	169 Temple st.
Colin Macrae Ingersoll,	*New Haven,*	85 Trumbull st.
Martin Edward Jensen,	*Cleveland, O.*	6½ York sq.
David Brown Lewis,	*Utica, N. Y.*	38 Elm st.
Earnest Theophilus Liefeld,	*New Haven,*	36 Orchard st.
Willey Solon McCrea,	*Chicago, Ill.*	36 Elm st.
John Moorhead,	*Pittsburgh, Pa.*	36 Elm st.
Carl Eugene Munger,	*Watertown,*	27 Prospect st.
Edward Butler Needham,	*Hartford,*	36 Elm st.
Frederic Adriance Osborn,	*New Haven,*	150 York st.
George Benjamin Phelps, Jr.	*Watertown, N. Y.*	36 Elm st.
Dwight Porter,	*Hartford,*	14 Lock st.
Edward Freeman Porter,	*Stowe, Vt.*	23 Prospect st.
Edward Villette Reynolds,	*Chicago, Ill.*	464 Chapel st.
Edwin McNeil Rogers,	*Central City, Col.*	66 w.
George Bliss Rogers,	*Lexington, Mass.*	36 Elm st.
Edward Rupert Sargent,	*New Haven,*	51 Elm st.
William Bartlett Schofield,	*West Point, N. Y.*	201 Orange st.
Henry Starkweather,	*New Haven,*	State Hospital.
Adrian Rowe Wadsworth,	*Farmington,*	165 Temple st.
William Candee Warren,	*Buffalo, N. Y.*	84 Wall st.
Adolph Frederic Wehner,	*New Haven,*	544 Chapel st.
George Goodwin Williams,	*Glastonbury,*	128 High st.

SENIORS, 43.

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JUNIOR CLASS.

Charles Francis Adams,	*Jessups, Md.*	36 Elm st.
Ethan Allen Andrews,	*Tarrytown, N. Y.*	175 Temple st.
George Jackson Angell,	*Brooklyn, N. Y.*	167 Temple st.
Edward Bailey,	*Harrisburgh, Pa.*	459 Chapel st.
Frank Lewis Bigelow,	*New Haven,*	278 Grange st.
George Frederick Bosworth,	*Milford,*	94 Olive st.
Lester Paige Breckenridge,	*Westfield, Mass.*	114 High st.
Charles Sheldon Burnham,	*Woodbridge,*	
Charles Monroe Carpenter, Jr.	*Brooklyn, N. Y.*	92 w.
Frederick Casper,	*West Meriden,*	196 Crown st.
Charles Chamberlain,	*Brooklyn, N. Y.*	55 Trumbull st.
Howard Field Chappell,	*Chicago, Ill.*	36 Elm st.
George Strong Daniels,	*New York City,*	92 w.
Harry Sprague Davidson,	*San Francisco, Cal.*	432 Chapel st.
Charles Manville Downs,	*New Haven,*	70 Wooster st.
Oliver Winchester Dye,	*New Haven,*	194 Prospect st.
John Slade Ely,	*New York City,*	71 w.
George Sherman Folsom,	*Northford,*	161 George st.
William Henry Fox,	*Washington, D. C.*	6½ York sq.
Seymour Francis Frasick,	*Hartford,*	99 Wall st.
Albert Moses Gerstle,	*Youngstown, O.*	6 Orange st.
Henry Holbrook Gladding,	*New Haven,*	170 Martin st.
William Loomis Griswold,	*Banksville,*	127 Whalley av.
Frederic Jonathan Hiller,	*Cohoes, N. Y.*	71 w.
Samuel Higgins,	*Buffalo, N. Y.*	74 High st.
Frank Allison Hubbard,	*Sandusky, O.*	59 w.
Blain Jamison,	*New Orleans, La.*	55 Trumbull st.
Jeme Tien Yow,	*Canton, China,*	169 Temple st.
Edmund Parker Lord,	*Saxonville, Mass.*	86 w.
Richard Becker Lyon,	*New Haven,*	710 Chapel st.
Silas Metzger,	*New Haven,*	17 Grove st.
Edwin Kirtland Morse,	*Poland, O.*	49 Grove st.
Marcus Daty Munn,	*Southington,*	127 Whalley av.
Marvin Olcott,	*Corning, N. Y.*	86 w.
Owyang Keng,	*Canton, China,*	169 Temple st.
Francis Stuyvesant Peabody,	*Chicago, Ill.*	36 Elm st.
Oliver Phelps,	*Canandaigua, N. Y.*	59 w.
Harry Smith Pope,	*Jersey City, N. J.*	57 w.
Addison Alexander Righter,	*Newark, N. J.*	73 w.
John Hutchinson Robinson,	*Lake Village, Ark.*	6½ York sq.
George Lewis Sargent,	*New Haven,*	51 Elm st.
Joseph Denny Sargent,	*New Haven,*	51 Elm st.
Louis Jacob Schiller,	*New Haven,*	8 Martin st.
Bernard Joseph Shanley,	*New Haven,*	211 Franklin st.
Frank Augustus Smith,	*New Haven,*	36 Lyon st.

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Henry Taber,	*New York City*,	33 Prospect st.
John Heyward Trumbull.	*Talcahuano, Chili*,	41 Trumbull st.
Richard Lindsay Trumbull,	*Talcahuano, Chili*,	41 Trumbull st.
John Henry Ullrich,	*Decatur, Ill.*	6½ York sq.
Howard VanRensselaer,	*Albany, N. Y.*	23 Prospect st.
Frank Charles Warner,	*West Suffield*,	305 Orange st.
Robert William Watson,	*Ashtabula, O.*	65 w.
Harry Yale Witbeck,	*Chicago, Ill.*	6½ York sq.
William Meeker Wood,	*Morristown, N. J.*	6 High st.
Arthur Burnham Woodford,	*West Winsted*,	116 College st.
Charles Worthington Wright.	*West Roxbury, Mass.*	82 Wall st.
Willis Benton Wright,	*Cromwell*,	88 Grove st.

JUNIORS, 57.

FRESHMAN CLASS.

Horace Ellsworth Andrews,	*Cleveland, O.*	162 York st.
Alfred Warren Armstrong,	*Cleveland, O.*	162 York st.
Charles Noyes Batcheller,	*Wallingford, Vt.*	60 w.
Henry Jonathan Biddle,	*Philadelphia, Pa.*	4 Library st.
Francis Hayes Blake,	*New Haven*,	Mill Rock.
Nathan Gross Bozeman,	*New York City*,	420 Chapel st.
Harry Weir Casey,	*Washington, D. C.*	82 Wall st.
William Anson Chamberlin,	*New Haven*,	30 Trumbull st.
Kee Yung Chun,	*Canton, China*,	169 Temple st.
Tsung Ching Chung,	*Canton, China*,	464 Chapel st.
William Henry Crocker,	*San Francisco, Cal.*	489 Chapel st.
Walter Root Downs,	*New Haven*,	64 La Fayette st.
James John Drummond,	*Winfield, Ill.*	25 Prospect st.
Robert Ogden DuBois,	*New Haven*,	328 Howard av.
George Mortimer Dunham,	*Unionville*,	60 w.
Richard Lawrence Everit,	*New Haven*,	281 Whitney av.
Herbert Waldron Faulkner,	*Stamford*,	59 Wall st.
Alexander Bryan Johnson,	*Utica, N. Y.*	64 w.
Herbert Deatherage Lacey,	*Brooklyn, N. Y.*	38 Elm st.
Frederick William La Forge,	*Waterbury*,	547 Chapel st.
Frank Judson Lambert,	*New Haven*,	12 Eld st.
Norman Smith Latham,	*Manchester*,	120 Dwight st.
Nathaniel White Lynde,	*West Brookfield, Mass.*	140 High st.
William Danforth MacQuesten,	*Washington, D. C.*	86 Wall st.
Walter Edward Malley,	*New Haven*,	714 Chapel st.

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Sheldon Elton Minor,	*Thomaston,*	547 Chapel st.
Nagamoto Okabe,	*Tokio, Japan,*	6 Trumbull st.
Edward E. Paramore,	*St. Louis, Mo.*	38 Elm st.
Frank Spooner Parrott,	*Bridgeport,*	94 Grove st.
Lewis Valentine Pirsson,	*New York City,*	121 Park st.
James Edward Pope, Jr.	*Jersey City, N. J.*	57 w.
Edward Rahm,	*Pittsburgh, Pa.*	56 w.
Robert Browning Rood,	*Great Barrington, Mass.*	8 Lock st.
Alfred Hughes Rowe,	*Fair Haven,*	Fair Haven.
William Bradbury Spring,	*Portland, Me.*	86 Wall st.
Charles Edward Stockder, Jr.	*West Meriden,*	6½ York sq.
Fred Moore Strong,	*Topeka, Kansas,*	38 Elm st.
Arthur Graham Thompson,	*Milford,*	6½ York sq.
Edwin Thorne,	*Garrisons, N. Y.*	65 Whitney av.
Thomas Pearsall Thorne,	*Millbrook, N. Y.*	65 Whitney av.
Walter Joy Vought,	*Buffalo, N. Y.*	110 w.
Edward Loder Whittemore,	*Rye, N. Y.*	143 York st.
Alfred Buckingham Willcox,	*Chicago, Ill.*	106 w.
Chauncey Pratt Williams, Jr.	*Albany, N. Y.*	134 College st.
S. Lawrence Williams,	*Chicago, Ill.*	86 Wall st.
Chan Lok Wing,	*China,*	59 Wall st.

FRESHMEN, 46.

SPECIAL STUDENTS NOT CANDIDATES FOR A DEGREE.

Samuel Forbes Adam,	*Canaan.*	
Louis Norton Bail,	*New Haven,*	43 Park st.
Louis Asta Buruaga,	*Santiago, Chili,*	109 Elm st.
Frederick Burr Clemmons,	*New Haven,*	162 Putnam st.
Edwin James Leonard,	*Davenport, Iowa,*	22 Trumbull st.
Joseph Singler,	*Ansonia.*	
Warren A. Spalding,	*New Haven,*	89 Church st.
Henry Roemer Stadtmueller,	*New Haven,*	43 Whitney av.
Louis Weld Stadtmueller,	*New Haven,*	43 Whitney av.

SPECIAL STUDENTS, 9.

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SUMMARY.

Graduates,	22
Seniors,	43
Juniors,	57
Freshmen,	46
Special,	9
Total,	177

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SHEFFIELD SCIENTIFIC SCHOOL.

I.

OBJECTS.

THE SHEFFIELD SCIENTIFIC SCHOOL is devoted to instruction and researches in the mathematical, physical, and natural sciences, with reference to the promotion and diffusion of science, and also to the preparation of young men for such pursuits as require especial proficiency in these departments of learning. It is one of the Departments of Yale College, like the law, medical, theological, and art schools, having its separate funds, buildings, teachers, and regulations, but governed by the Corporation of Yale College, which appoints the professors and confers the degrees. It is, in part, analogous to the academic department, or classical college, and, in part, to the professional schools.

The instruction is intended for two classes of students:—

I. Graduates of this or of other Colleges, and other persons qualified for advanced or special scientific study.

II. Undergraduates who desire a training chiefly mathematical and scientific, in less part linguistic and literary, for higher scientific studies, or for various other occupations to which such training is suited.

II.

HISTORY AND ORGANIZATION.

The School was commenced in 1847. In 1860, a convenient building and a considerable endowment were given by Joseph E. Sheffield, Esq., of New Haven, whose name, at the repeated request of the Corporation of Yale College, was afterward attached to the foundation. Mr. Sheffield has since frequently and munificently increased his original gifts.

In 1863, by an act of the Connecticut Legislature, the national grant for the promotion of scientific education (under the congressional enactment of July, 1862) was given to this department of Yale College, which thus became "the College of Agriculture and the Mechanic Arts for Connecticut." Since that time, and especially since the autumn of 1869, numerous liberal gifts have

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been received from the citizens of New Haven, and from other gentlemen in Connecticut, New York, and St. Louis, for the endowment of the School, and the increase of its collections.

The action of the State led to the designation by law of a State Board of Visitors, consisting of the Governor, Lieutenant-Governor, three senior Senators, and the Secretary of the State Board of Education; and this Board, with the Secretary of the Scientific School, is also the Board for the appointment of students to hold the State scholarships.

At the request of the Governing Board, the Corporation of Yale College has also appointed a Board of Councillors for the School, consisting of a number of gentlemen who have taken a deep interest in its welfare.

The Governing Board consists of the President of Yale College and the Professors who are permanently attached to the School. There are several other instructors associated with them, a part of whom are connected with other departments of the College.

III.

BUILDINGS AND APPARATUS.

The two buildings in which the work of instruction in the Scientific School is mainly carried on are called Sheffield Hall and North Sheffield Hall; but instruction in Mineralogy, Geology, and Biology, including Zoölogy and Comparative Anatomy, is now given entirely in the Peabody Museum. These halls contain a large number of recitation and lecture rooms, a hall for public assemblies and lectures, chemical and metallurgical laboratories, a photographical room, an astronomical observatory, museums, a library and reading room, besides studies for some of the professors, where their private technical libraries are kept.

The following is a summary statement of the collections belonging to the School:

1. Laboratories and Apparatus in Chemistry, Metallurgy, Physics, Photography, and Zoölogy.
2. Metallurgical Museum of Ores, Furnace Products, etc.
3. Agricultural Museum of Soils, Fertilizers, useful and injurious insects, etc.
4. Collections in Zoölogy.
5. Astronomical Observatory, with an equatorial telescope by Clark and Sons of Cambridge, a meridian circle, etc.
6. A Collection of Mechanical Apparatus, constituting the "Collier Cabinet."

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7. Models in Architecture, Geometrical Drawing, Civil Engineering, Topographical Engineering, and Mechanics; diagrams adapted to public lectures; instruments for field practice.

8. Maps and Charts, topographical, hydrographical, geological, etc.

The herbarium of Professor Brewer, and the astronomical instruments of Professor Lyman, are deposited in the buildings. Professor Eaton's herbarium, near at hand, is freely accessible. Students also have access to the various laboratories and collections in Natural Science in the Peabody Museum.

Students are also admitted, under varying conditions, to the College and Society libraries, the College Reading Room, the School of the Fine Arts, and the Gymnasium.

IV.

THE LIBRARY.

The special technical library of the Scientific School consists of about five thousand volumes. Included in this is the "Hillhouse Mathematical Library" of twenty-four hundred volumes, collected during a long series of years by Dr. William Hillhouse, and in 1870 purchased and presented to the Institution by Mr. Sheffield. A catalogue of this collection forms a supplement to the Annual Report of the Governing Board for 1870. All the prominent scientific journals of this country and of Europe, together with the proceedings of foreign academies, and of scientific societies, can be found either in this library or in the College Library to which students have access.

V.

INSTRUCTION FOR GRADUATE AND SPECIAL STUDENTS.

Persons who have gone through undergraduate courses of study, here or elsewhere, may avail themselves of the facilities of the School for more special professional training in the physical sciences and their applications, gaining in one, two, or three years the degree of Bachelor of Philosophy, or, in two additional years of Engineering study, that of Civil Engineer, or of Dynamic Engineer.

Or, engaging in studies of a less exclusively technical character, they may become candidates for the degree of Doctor of Philosophy. The instruction in such cases will be adapted to the particular needs and capacities of each student, and may be combined with that given by the graduate instructors in other departments

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of the University. This degree is conferred upon those who, having already taken a Bachelor's degree, engage as students in the Department of Philosophy and the Arts for not less than two years in assiduous and successful study. It is not given upon examination to those whose studies are pursued elsewhere. The requirements for it will in some cases exact of the student more than two years of post-graduate labor; so, especially, wherever the course of undergraduate study has been, as in the Scientific School, of less than four years. The candidate must pass a satisfactory final examination, and present a thesis giving evidence of high attainment in the branches of knowledge to which he has attended. A good knowledge of Latin, German and French will be required in all cases, unless, for some exceptional reason, the candidate be excused by the Faculty. The graduating fee is ten dollars.

Subjects likely to receive special attention are suggested as follows:

Professor NORTON will instruct in applied mechanics and in spherical astronomy.

Professor LYMAN, in the use of meridional and other astronomical instruments, and in astronomical spectroscopy.

Professor DUBOIS, in the principles of thermodynamics, and utilization of heat as a source of power.

Professor BRUSH, in the analysis and determination of mineral species, and in descriptive mineralogy.

Professor JOHNSON, in theoretical, analytical, and agricultural chemistry.

Professor BREWER, in agriculture and forest culture, in the use of the microscope, and in physical geography.

Professor CLARK, in definite integrals, differential equations, analytical mechanics, the theory of numerical approximations, and the method of least squares.

Professor EATON, in structural and systematic botany, including the North American flora and the description of genera and species.

Professor WALKER, in public finance and in the statistics of industry.

Professor ALLEN, in analytical chemistry, and in metallurgy.

Professor VERRILL, and Professor SMITH, in zoölogy and geology.

The same courses of study are open, for a longer or shorter time,

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to graduate students who do not desire to become candidates for a degree.

Students who have taken the degree of Bachelor of Philosophy, may obtain the degree of CIVIL or of DYNAMIC ENGINEER at the end of two academical years, by pursuing the following higher course of study and professional training.

The course of study for the degree of CIVIL ENGINEER will comprise—

1. Higher Calculus. Higher Geometry. Theory of Numerical Operations.
2. Analytical Mechanics. Mechanics applied to Engineering,
3. A Course of Construction and Design. Projects.
4. Practical Astronomy, with use of instruments, computations, etc.

This course will occupy one year.

To secure the requisite amount of professional knowledge and practice, the candidate will be required to furnish a comprehensive report of the results of an examination into the existing condition of some special line of constructive art; or to present proper evidence that he has had actual charge in the field, for several months, of construction or surveying parties, or held some responsible position deemed equivalent to this.

An elaborate design must also be submitted of some projected work of construction, based upon exact data obtained from careful surveys made by the candidate, and comprising all the requisite calculations, and the necessary detailed drawings, and accompanied by full specifications of the work to be done, and the requirements to be met by the contractor.

The fee for this degree is five dollars.

The course of study for the degree of DYNAMIC ENGINEER will comprise—

1. Higher Calculus. Higher Geometry. Theory of Numerical Operations.
2. General Principles of Dynamics (Analytical Mechanics), including special application of these principles to Dynamical problems.
3. Construction of Machines. Designs.
4. Preparation of theses on special subjects in Dynamic Engineering.

During the second year candidates will be permitted to employ such a portion of their time as may be deemed advisable or necessary in the examination of engineering works and manufacturing establishments, and may also have the privilege of entering upon professional practice, provided it is done with the knowledge and consent of the Professor of Dynamic Engineering, and under such circumstances as shall appear to him to be favorable to professional progress.

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An elaborate thesis on some professional subject, with an original design, or project, accompanied by proper working drawings, will be required at the end of the second year.

The fee for this degree is five dollars.

SPECIAL STUDENTS.—For the benefit of those who, being fully qualified, desire to pursue particular studies without reference to the obtaining of a degree, special or irregular students are received in most of the departments of the School; not, however, in the Select Course or in the Freshman Class.

It should be distinctly understood that these opportunities are not offered to persons who are incompetent to go on with regular courses, but are designed to aid those who, having received a sufficient preliminary education elsewhere, desire to increase their proficiency in special branches.

VI.

REQUIREMENTS FOR ADMISSION AND COURSES OF INSTRUCTION FOR UNDERGRADUATE STUDENTS.

TERMS OF ADMISSION.—Candidates must be not less than fifteen years of age, and must bring satisfactory testimonials of moral character from their former instructors or other responsible persons.

For admission to the Freshman Class the student must pass a thorough examination in the following subjects:

English—including grammar, spelling and composition. In grammar, Whitney's Essentials of English Grammar, or an equivalent.

History of the United States.

Geography.

Latin—six books of Cæsar's Commentaries, or their equivalent, and simple exercises in prose composition.

Arithmetic—including the metric system of weights and measures.

Algebra—so much as is contained in Loomis's Treatise, up to the general theory of equations.

Geometry—Plane, solid and spherical; including fundamental notions of symmetry, and examples of loci and of maxima and minima of plane figures:—an equivalent of the nine books of Chauvenet's Treatise, or of the ten books of Loomis's Elements and the Appendix, up to the section on Transversals.

Trigonometry—including the analytical theory of the trigonometrical functions, and the usual formulæ; the construction and use of trigonometrical tables; and the solution of plane triangles;—so much, for example, as is contained in Wheeler's Plane Trigonometry (Boston, 1877), or Richards's Plane Trigonometry (New York, 1878).

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While no entrance examination is held in the *History of England*, candidates for admission are urgently advised to make themselves as familiar as possible with that subject; as a knowledge of it is essential to the most successful prosecution of some of the studies of the course.

Candidates will be allowed the option of passing on the above-named subjects in two successive years. In such a case they must present themselves for examination at the June examination of the first year in the following subjects or parts of subjects: *History of the United States*, *Geography*, *Arithmetic*, *Plane Geometry*, and *Algebra to Quadratic Equations*.

In order to have this preliminary examination counted, candidates must pass satisfactorily on *all* the subjects; and notice must be given of the intention to divide the examination to Professor G. J. Brush, Executive Officer of the School, on or before June 15.

In his preparation in GEOMETRY the candidate should, as far as practicable have suitable exercises in proving simple theorems and solving simple problems for himself. It is important, too, that he should be accustomed to the numerical application of geometric principles, and especially to the prompt recollection and use of the elementary formulæ of mensuration. In TRIGONOMETRY he should be exercised in applying the usual formulæ to a variety of simple reductions and transformations, including the solution of trigonometrical equations. Readiness and accuracy in trigonometrical calculations are also of prime importance to the candidate. If the use of logarithms is postponed in his preparation till Trigonometry is taken up (which is by no means necessary or advisable), he should then have abundant applications of them to all forms of calculation occurring in ordinary practice, as well as to those appearing in the solution of triangles. Finally, in all of his calculations, he should study the art of neat orderly, and readily intelligible arrangement.

In LATIN, in order to secure the attainment of the required proficiency, the student should have such continued training in parsing as shall make him thoroughly familiar with declensions and conjugations, and accurate and ready in the application of the rules of syntax. As an additional guarantee of the proper mastery of these grammatical elements, the requirement has been adopted of "simple exercises in prose composition." By this is meant merely, such a course of elementary exercises in translation, orally and in writing, from English into Latin as, in connection with the systematic parsing just mentioned, shall necessitate a familiarity with grammatical forms and the leading principles of syntax, and thus render the reading of the six books of Cæsar (or their equivalent) more thorough and fruitful. Since this course of elementary exercises in translation is designed as a preparation for reading, and not as a sequel to it, it should be invariably begun at the earliest stage of the study of Latin. To avoid any misapprehension of the nature of the extent of the requirement, the following works are specifically, named, among which the candidate for examination may make his own selection.

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These are Harkness's "Introduction to Latin Composition," 112 pages; Leighton's "Latin Lessons," 91 pages; Smith's "Principia Latina," Part I.; McClintock's "First Latin Book," 83 lessons (193 pp.). Any equivalent of these may be offered from the many useful books of a similar character. A knowledge of Prosody is not required.

The examinations for admission take place at North Sheffield Hall, on Friday and Saturday, July 2, 3, and on Tuesday and Wednesday, September 14, 15, 1880. Opportunities for private examinations may, in exceptional cases, be given at other times.

In 1880 examinations (for the Freshman Class only) will also be held in Chicago and in Cincinnati (beginning on Friday, July 2, at 9 A. M.), at a place to be announced in the local newspapers of the day previous. Candidates who propose to be present are requested to send their names to Professor G. J. Brush, Executive Officer of the School, before June 15. A fee of five dollars will be charged for admission to these examinations.

Candidates for advanced standing in the undergraduate classes are examined, in addition to the preparatory studies, in those already pursued by the class they wish to enter. No one can be admitted as a candidate for a degree, later than at the beginning of the Senior year.

THE COURSES OF INSTRUCTION, occupying three years, are arranged to suit the requirements of various classes of students. The first year's work is the same for all; for the last two years the instruction is chiefly arranged in special courses. The special courses most distinctly marked out are the following:—

(*a.*) In Chemistry;
(*b.*) In Civil Engineering;
(*c.*) In Dynamical (or Mechanical) Engineering;
(*d.*) In Agriculture;
(*e.*) In Natural History;
(*f.*) In Biology preparatory to Medical Studies;
(*g.*) In studies preparatory to Mining and Metallurgy;
(*h.*) In Select studies preparatory to other higher studies.

The arrangement of the studies is indicated in the annexed scheme.

FRESHMAN YEAR—INTRODUCTORY TO ALL THE COURSES.

FIRST TERM—*German*—Whitney's Grammar and Reader. *English*—Lounsbury's History of the English Language; Exercises in Composition. *Mathematics*—Analytical Geometry. *Physics*—Atkinson's Ganot, with experimental lectures. *Chemistry*—Recitations and Laboratory practice. *Elementary Drawing*—Practical Lessons in the Art School.

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SECOND TERM—*Language, Physics, and Chemistry*—as stated above. *Mathematics*—Spherical Trigonometry (Wheeler's); Elements of Mechanics. *Physical Geography*—Lectures. *Botany*—Gray's Lessons, with Lectures. *Political Economy*—Elementary Lectures. *Drawing*—Elementary Projection Drawing; Isometric Drawing; Descriptive Geometry.

For the Junior and Senior years the students select for themselves one of the following courses:—

(a.) IN CHEMISTRY.

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. *Qualitative Analysis*—Fresenius's. *Laboratory Practice. Blowpipe Analysis. German. French.*

SECOND TERM—*Laboratory Practice*—Quantitative Analysis. *Mineralogy*—Blowpipe Analysis and Determination of Species. Lectures. *French. German.*

SENIOR YEAR:

FIRST TERM—*Organic Chemistry*—Lectures and Recitations. *Agricultural Chemistry*—Recitations (optional). *Laboratory Practice*—Volumetric and Organic Analysis. *Geology*—Dana's. *Zoology*—Lectures and Excursions. *French.*

SECOND TERM—*Laboratory Practice*—Mineral Analysis and Assaying. *Geology*—Dana's Manual. *Metallurgy* (optional). *Mineralogy* (optional). *French.*

(b.) IN CIVIL ENGINEERING.

JUNIOR YEAR:

FIRST TERM—*Mathematics*—Elements of the Theory of Functions; Numerical Equations; Differential Calculus. *Surveying*—Field Operations. *Drawing*—Descriptive Geometry, continued, including Warped Surfaces. *German. French.*

SECOND TERM—*Mathematics*—Integral Calculus. Rational Mechanics. *Drawing*—Shadows, Perspective, and Gearing; Topographical. *Surveying*—Topographical. *German. French.*

SENIOR YEAR:

FIRST TERM—*Field Engineering*—Laying out Curves; Location of line of Railroad, with calculations of Excavation and Embankment; Henck's Field Book for Railroad Engineers. *Civil Engineering*—Resistance of Materials; Bridges and Roofs, begun; Stone Cutting, with graphical problems. *Geology*—Dana's. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *French.*

SECOND TERM—*Civil Engineering*—Bridges and Roofs; Building Materials; Stability of Arches and Walls; Mahan's Civil Engineering. *Dynamics*—Principles of Mechanism; Steam Engine. *Hydraulics*—Hydraulics and Hydraulic Motors. *Drawing*—Graphical Statics. *Astronomy*—Loomis's Astronomy, with practical problems. *Mineralogy*—continued. *Geology*—Dynamic. *French.*

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(c.) IN DYNAMIC ENGINEERING.

JUNIOR YEAR:

FIRST TERM—*Mathematics*—Elements of the Theory of Functions; Numerical Equations; Differential Calculus. *Surveying*—Field Practice. *Drawing*—Descriptive Geometry, continued, including Warped Surfaces. *German. French.*

SECOND TERM—*Mathematics*—Integral Calculus. Rational Mechanics. *Kinematics*—General Theory of Motion and Principles of Mechanism; Elementary Combinations of pure Mechanism; Pulleys and Belts; Gearing and forms of teeth for wheels; Parallel Motions. *German. French.*

SENIOR YEAR:

FIRST TERM—*Statics*—The application of the Principles of Statics to Rigid Bodies; Elasticity and Strength of Materials; Forms of Uniform Strength; Stability of Structures; Theory of the Arch; Construction of Roof Trusses, Girders and Iron Bridges. *Machine Drawing*—Bolts and Nuts; Riveting; Journals, Axles, Shafts, Couplings, Pillow-Blocks; Shaft-hangers, Pulleys; Connecting Rods and Cranks, Cross-heads; Pipe Connections, Valves, Cylinders, Stuffing Boxes, Glands, etc. *Shop Visits.* Blowpipe Analysis. *French.*

SECOND TERM—*Hydrostatics*—Equilibrium and Pressure of fluids; Hydrometers, Manometers, Gauges, etc. *Hydrodynamics*—Water Engines and Water Wheels; Construction of Water Reservoirs and Conduits; Measurement of Water Supply; Discharge of Pipes. *Thermodynamics*—General principles of Heat employed as a source of Power; Construction of Steam Engines; Hot Air Engines; Gas Engines. *Machine Designing*—Proportioning of Machine Parts, continued. Designs for Machines with working drawings. Design for Hoisting Engine; Shearing and Pumping Engine; High Speed Steam Engine. *Shop Visits and Reports. Metallurgy.*

(d.) IN AGRICULTURE.

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. *Qualitative Analysis* — Fresenius's. *Laboratory Practice. Blowpipe Analysis. German. French.*

SECOND TERM—*Organic Chemistry*—Lectures and Recitations. *Laboratory Practice*—Quantitative Analysis. *Mineralogy*—Blowpipe Analysis and Determination of Species. *Physical Geography*—Lectures. *Physiology*—Huxley's. *Botany*—Lectures. *French. German.*

SENIOR YEAR:

FIRST TERM—*Agriculture*—Cultivation of the Staple Crops of the Northern States. Tree Planting and Forestry. *Agricultural Chemistry*—Johnson's. *Geology*—Dana's. *Zoology. English. French.*

SECOND TERM—*Agriculture*—Laws of Heredity and Principles of Breeding; Lectures. *Geology*—Dana's. *Rural Economy*—History of Agriculture and Sketches of Husbandry in Foriegn Countries; Systems of Husbandry. *Agricultural Chemistry*—Johnson's. *Geology*—Dana's. *Zoology. Botany. Microscopy. English. French.*

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(e.) IN NATURAL HISTORY.

(Either Geology, Mineralogy, Zoology, or Botany, may be made the principal study, some attention in each case being directed to the other three branches of Natural History).

JUNIOR YEAR:

FIRST TERM—*Chemistry*—Qualitative Analysis; Laboratory Practice; Recitations. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *Botany*—Gray's Manual; Laboratory Practice. *German. French.*

SECOND TERM—*Zoology*—Laboratory Practice; Recitations; Excursions (land and marine). *Botany*—Laboratory Practice; Excursions. *Physiology*—Huxley's. *Mineralogy*—continued. *Physical Geography. German. French.*

SENIOR YEAR:

FIRST TERM—*Geology*—Dana's. Excursions. *Zoology*—Laboratory Practice Lectures; Recitations; Excursions. *Botany*—Herbarium Studies; Gray's Textbook; Excursions. *French.*

SECOND TERM—*Geology*—Dana's. *Anatomy of Vertebrates*—Huxley's. *Zoology*—Laboratory Practice; Recitations; Lectures. *Botany*—Herbarium Studies, especially in the Cryptogamous Orders; Botanical Literature; Essays in Descriptive Botany. *Meteorology. French.*

Besides the regular courses of recitations and lectures on structural and systematic Zoology and Botany, and on special subjects, students are taught to prepare, arrange, and identify collections, to make dissections, to pursue original investigations, and to describe genera and species in the language of science. For these purposes, large collections in Zoology and Palæontology belonging to the College are available, as are also the private botanical collections of Professor Eaton.

(f.) IN BIOLOGY—PREPARATORY TO MEDICAL STUDIES.

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. *Qualitative Analysis*—Fresenius's; Laboratory Practice; Recitations. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *German. French.*

SECOND TERM—*Physiology*—Huxley's, with Demonstrations. *Toxicology*—Fresenius's; Laboratory Practice; Recitations and Lectures. *Physiological Chemistry*—Sanderson's Handbook. Recitations and Laboratory Work. *Mineralogy*—continued. *Botany*—Lectures, Practical Exercises in Phenogamous Plants, and Excursions. *German. French.*

SENIOR YEAR:

FIRST TERM—*Physiological Chemistry*—continued. *Organic Chemistry*—Lectures and Recitations. *Zoology*—Lectures. *Botany*—Practical Exercises, Lectures and Excursions. *Geology*—Dana's Manual. *French.*

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SECOND TERM—*Comparative Anatomy and Histology*—Laboratory Practice and Recitations. *Geology*—Dana's Manual. *Zoology*—Lectures. *Laws of Heredity and Breeding*—Lectures. *French.*

(g.) IN STUDIES PREPARATORY TO MINING AND METALLURGY.

Young men desiring to become Mining Engineers, can pursue the regular course in Civil or Mechanical Engineering, and at its close can spend a fourth year in the study of metallurgical chemistry, mineralogy, etc.

(h.) IN THE SELECT STUDIES PREPARATORY TO OTHER HIGHER STUDIES.

JUNIOR YEAR:

FIRST TERM—*Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *Astronomy. English*—Early English. *History*—Freeman's Outlines. *French. German.*

SECOND TERM—*Mineralogy*—Lectures. *Physical Geography*—Guyot; Lectures. *Botany*—Lectures; Excursions; Laboratory Practice. *English*—Chaucer, Bacon, Shakspere. *History*—Freeman's Outlines, with Lectures. *Political Economy*—Roger's Manual. *German. French.*

SENIOR YEAR:

FIRST TERM—*Geology*—Recitations and Excursions. *Zoology*—Lectures and Excursions. *Linguistics*—Whitney's Life and Growth of Language. *English*—Shakspere. *History*—Constitutional History of the United States; Lectures. *Political Economy*—Lectures. *French.*

SECOND TERM—*Geology*—continued. *Meteorology*—Lectures. *Political Economy*—Lectures. *English*—Shakspere, Milton, Dryden, Pope, and later authors. *History*—Political History of United States. History of Europe from 1848; Lectures. *French.*

Exercises in English Composition are required during the entire course from all the students. The preparation of graduating theses is among the duties of the Senior Year.

Lectures on Military Science and Tactics are annually given by General Abbott, and other officers of the Engineer Corps of the United States Army.

DRAWING.—The course in drawing extends through the three years. During the first term of Freshman year, the students practice free-hand drawing at the Art School building, under the direction of Professor Niemeyer, of the Yale School of the Fine Arts. After the completion of the course in free-hand drawing, instruction is given by Mr. F. R. Honey, during the second term

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in the elementary principles of instrumental drawing, embracing Elementary projection drawing, Isometric drawing, and Descriptive Geometry as far as Warped Surfaces. This course is obligatory upon all.

During the Junior and Senior years, instruction in drawing is obligatory only on the students in Civil and Mechanical Engineering. In the former year the system of instruction embraces shades and shadows, tinting, perspective, and warped surfaces. By this method all the problems in Descriptive Geometry are required to be worked out on the drawing-board instead of the black-board. The course extends through the entire year, and is under the direction of Mr. Honey.

In Senior year, students are required to apply the principles of drawing already obtained to works of construction, under the general supervision of the Professors of Civil and of Dynamic Engineering.

VII.

METHODS OF INSTRUCTION.

The instruction of this institution is given chiefly in small class rooms, in connection with recitations and by familiar lectures, illustrated by the apparatus at the command of the various teachers. In many studies weekly excursions are made for the purpose of collecting specimens and examining natural phenomena.

In Chemistry and Metallurgy the students work several hours daily in well-appointed laboratories, under the direct superintendence of the instructors, and are guided through systematic courses of quantitative and qualitative analysis, assaying, and the blow-pipe determination of minerals and ores.

In Botany, during the summer of Junior year, exercises in analyzing and identifying plants occur two or three times a week, followed by practice in writing characters and descriptions of plants from living specimens. Students are shown also the best methods of collecting and preserving for future study, specimens of Flowering Plants, Ferns, Mosses, Algæ, etc. In the autumn term of Senior year the work of the summer is continued. Students are encouraged to pursue special lines of Botanical investigation, and varied assistance is rendered them according to their needs. The final examination is intended to show what they have learned, and the collections they have made are considered to be of minor importance.

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In Zoology excursions are made during the third term of Junior and first term of Senior year, in company with the instructors, for the purpose of observing the habits and making collections of marine, fresh-water, and terrestrial animals of all classes. Each student is required to prepare and present for examination a collection containing a specified number of species, and illustrating the various classes of animals. He must also be able to pass an examination upon his collection, at least to the extent of explaining the classes and orders illustrated, and showing why particular specimens belong to the respective classes.

In Geology excursions are made for the purpose of examining geological phenomena and making special collections of rocks and minerals. Each student is required to pass a satisfactory examination on his collections at the end of the first term of Senior year.

In addition to the above, a course of lectures is given every winter by the professors of the schools and others, on topics of popular interest.

VIII.

TUITION CHARGES.

The charge for tuition for undergraduate students is $150 per year, payable, $55 at the beginning of the first and of the second term, and $40 at the middle of the second term. The special student of Chemistry has an additional charge of $70 per annum for chemicals and use of apparatus. He also supplies himself at his own expense with gas, flasks, crucibles, etc., the cost of which should not exceed $10 per term. A fee of $5 is charged members of the Freshman Class for chemicals and materials used in their laboratory practice, and the same fee is required from all (except Chemical students) who take the practical exercises in Blow-pipe Analysis and Determinative Mineralogy. A fee of $5 a term will also be charged to the students in the Zoological Laboratory, for materials and use of instruments. An additional charge of $5 is annually made to each student for the use of the College Reading Room and Gymnasium.

For graduate students the charge for tuition is $100 per year.

IX.

CHURCH SITTINGS.

Free sittings for students in this department of Yale College are provided as follows: in the Center Church (Cong.); in the Trinity (Epis.); and in the First Methodist Church.

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Those who prefer to pay for a sitting for a year, more or less, in the churches above mentioned, or in any other church of any denomination, will be aided on application to the Secretary of School.

Sittings in the Gallery of the College Chapel are free as heretofore to the students of this department.

X.

DEGREES.

Students of this department, on the recommendation of the Governing Board, are admitted by the Corporation of Yale College to the following degrees. They are thus conferred:

1. Bachelor of Philosophy: on those who complete any of the three-years courses of study, passing all the examinations in a satisfactory manner, and presenting a graduation thesis.

The fee for graduation as Bachelor of Philosophy, including the fee for Triennial Catalogues, Commencement Dinners, etc., is $10; unless the person taking the degree is also an academical graduate, when it is but $5.

2. Civil Engineer and Dynamical Engineer: The requirements for these degrees are stated on pages 17–18.

3. Doctor of Philosophy: The requirements for this degree are stated on page 16.

XI.

TERMS AND VACATIONS.

The next academic year begins Thursday, September 16, 1880. The first term begins eleven weeks from Commencement-day and continues fourteen weeks: the second term begins on the second Thursday in January and continues until Commencement-day, with a Spring recess—usually of eight days—including Easter. (See Calendar, p. 2.)

XII.

ANNOUNCEMENT IN RESPECT TO STATE STUDENTS.

The scholarships established in this School in consequence of the bestowal upon it of the Congressional grants are designed to aid young men who are in need of pecuniary assistance in fitting themselves for agricultural and mechanical pursuits of life. All applicants must be citizens of Connecticut. In case there are more

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applicants than vacancies, candidates will be preferred who have lost a parent in the military or naval service of the United States, and next to these such as are most in need of pecuniary assistance; and the appointments will be distributed as far as practicable among the several counties in proportion to their population. The appointing Board for the current year, consisting of the Board of Visitors of the State and the Secretary of the School, will meet on June 29th, 1880, and at or about the same time in the year 1881, due notice of which will be given by publication in every county of the State. All applications should be made previous to that time. Blank forms for application will be sent, when requested, by Professor GEORGE J. BRUSH, Secretary of the Appointing Board.

XIII.

ANNIVERSARY.

The Anniversary of the School is held on Tuesday of the Commencement week in Yale College, when selections from the graduation theses are publicly read. The degrees are publicly conferred by the President and Fellows of Yale College on Commencement Day.

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APPENDIX.

ENTRANCE EXAMINATION PAPERS.

The following are the papers for 1879, upon which applicants for admission were examined at the June and September examinations.

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ARITHMETIC.

JUNE, 1879.

1. Find the least common multiple of 7379 and 9263.

2. Reduce 525 metres to feet.

3. If $9\frac{1}{2}$ yards of cloth can be bought for $\$44\frac{1}{8}$, how many yards can be bought for $\$33\frac{1}{4}$?

4. For what sum must a note be given at bank, payable in 5 months, at 6 per cent. discount, to obtain $1000?

5. By selling land at $88.14 per acre, I shall gain 13 per cent. For how much must I sell it to gain 20 per cent.?

6. A certain room is 16 feet long, 15 feet wide and 12 feet high. What is the distance from the right hand upper corner to the left hand lower corner?

ARITHMETIC.

SEPTEMBER, 1879.

1. Reduce to its lowest terms $\frac{8398}{29393}$.

2. If 5 men build 75 rods 2 ft. 6 in. of wall in 7 days, how much will 1 man build in 1 day?

3. An agent bought land at 5 per cent. commission. The amount of his commission was $150. What amount did he pay for land?

4. A owes B $15,000, $\frac{1}{3}$ due in 3 years, $\frac{1}{3}$ in 4 years, $\frac{1}{3}$ in 6 years, and the balance in 8 years; what is the equated time for the payment of the whole?

5. Name the principal metric units of length, weight, and capacity. State their relations to one another, and give an equivalent of each in the common system.

6. Two globes, each 5 inches in diameter, and 2 cubes, each 5 inches in length, were melted into one cube; how long was the side of this cube?

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GEOMETRY.

JUNE, 1879.

[State what text-book you have studied and to what extent.]

I.—*Plane Geometry.*

1. Define similar polygons. Prove that two triangles are similar when they are mutually equiangular.

2. Two triangles having an angle of the one equal to an angle of the other are to each other as the products of the sides including the equal angles.

3. To inscribe a circle in a given triangle.

4. The side of a regular inscribed hexagon is equal to the radius of the circumscribed circle.

5. Define the term *locus* and give an example of a plane locus. When are two points said to be symmetrical with respect to a straight line, and what is the line then called? Of all triangles having the same base and equal perimeters, what one has the greatest area? How do you find the circumference and area of a circle when the radius is given? how, the area of a trapezoid? how, that of a regular polygon?

II.—*Solid and Spherical Geometry.*

6. If two angles, not in the same plane, have their sides respectively parallel and lying in the same direction, they are equal and their planes are parallel.

7. If a pyramid be cut by a plane parallel to its base: 1st, the edges and the altitude will be divided proportionally; 2d, the section will be a polygon similar to the base.

8. If two triangles on the same sphere are mutually equilateral, they are also mutually equiangular.

9. Write expressions for the surface and volume of a sphere, the surface of a zone, and the volume of a spherical sector.

NOTE.—Candidates who present themselves for the whole examination may omit questions 2 and 3.

Candidates who present themselves for the partial examination, will answer the questions only in Plane Geometry.

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GEOMETRY.

SEPTEMBER, 1879.

[State what text-book you have studied and to what extent.]

1. To construct a triangle equivalent to a given polygon.
2. To inscribe a regular decagon in a given circle.
3. If two planes are perpendicular to each other, a straight line drawn in one of them perpendicular to their intersection is perpendicular to the other.
4. Define a polyhedron and a prism. The sections of a prism made by parallel planes are equal polygons.
5. Define a polar triangle.

   1. If A′B′C′ is the polar triangle of ABC, then ABC is the polar triangle of A′B′C′.

   2. In two polar triangles each angle of one is measured by the supplement of the side opposite to it in the other.

6. The convex surface of a cone of revolution is equal to the product of the circumference of its base and half its slant height.

ENGLISH.

JUNE, 1879.

1. Parse the words in the following sentences:—
   (*a*) The course that he took was one which, under the circumstances, could not be justified.
   (*b*) To fly from need not be to hate mankind.
2. State the various classes of nouns.
3. Inflect throughout the pronoun of the third person.
4. Explain the characteristics of the two conjugations of the English verb, the Old or Strong, and the New or Weak conjugation; and give illustrative examples of each.

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ALGEBRA.

JUNE, 1879.

[State what text-book you have studied and to what extent.]

I.

1. Find the greatest common divisor of

$$3x^3-13x^2+23x-21 \text{ and } 6x^3+x^2-44x+21.$$

2. A grocer has two kinds of tea, one worth a cents per pound, the other b cents. How many pounds of each must be taken to form a mixture of n pounds which shall be worth c cents per pound?

3. Given $x-\frac{y-a}{b}=c$; $y-\frac{a-x}{b}=d$, to find x and y.

4. (1.) From $\sqrt[3]{192}$ take $\sqrt[3]{24}$. (2.) Divide $4\sqrt[3]{12}$ by $2\sqrt{3}$. (3.) Divide $a^{\frac{1}{2}}+64b^{\frac{1}{2}}$ by $a^{\frac{1}{6}}+4b^{\frac{1}{6}}$. (4.) Multiply $\sqrt{-a}+\sqrt{-b}$. by $\sqrt{-a}-\sqrt{-b}$.

II.

5. A person bought a number of sheep for a dollars. If he had bought $2b$ more for the same money, he would have paid c dollars less for each. How many did he buy?

6. Resolve the trinomial $3x^2-10x-25$ into factors.

7. Deduce the formula for finding the number of permutations (or arrangements) that can be made of n things taken m at a time.

8. Write the formula for the development of $(x+a)^m$. If m is entire and positive, how many terms will it contain? How many, in any other case?

9. Define the logarithm of a number and a system of logarithms. What is the base of the common system? In this system what numbers have negative logarithms? What logarithms would be negative in a system formed with the base 0.5?

What operations are facilitated by the use of logarithms? Give the rules for performing them.

10. Obtain a formula for finding in what time a sum of money will double at a given rate of compound interest?

NOTE.—The first division of the paper extends as far as Quadratic Equations, and will be all that is required of candidates who propose to pass the partial examination only.

Candidates who present themselves for examination in the whole of the required Algebra, may omit questions 1 and 2.

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ALGEBRA.

SEPTEMBER, 1879.

[State what text-book you have studied and to what extent.]

Given $\frac{m}{x}+\frac{n}{y}=a$; $\frac{n}{x}+\frac{m}{y}=b$, to find x and y.

Simplify the following expressions:

(1.) $\sqrt[3]{27x^6y^{15}}$; (2.) $8(\frac{3}{4})^{\frac{1}{2}}+\frac{1}{2}(12)^{\frac{1}{2}}-\frac{1}{3}(27)^{\frac{1}{2}}-2(\frac{3}{16})^{\frac{1}{2}}$;

(3.) $[ab^3.(ab^3)^{\frac{1}{2}}.(ab^4)^{\frac{1}{3}}.(ab^5)^{\frac{1}{4}}]^{\frac{1}{5}}$; (4.) $(\sqrt[8]{-1})^4$.

Solve the equation $3x-\frac{6x^2-40}{2x-1}-\frac{3x-10}{9-2x}=2$.

Solve the equation $\frac{\sqrt{a+x}}{\sqrt{x}}+\frac{\sqrt{a-x}}{\sqrt{x}}=\sqrt{\frac{x}{b}}$.

What debt may be discharged in a year by paying $1 the month, $2 the second, $4 the third, and so on, each succeed-payment being double the last; and what will be the last nent?

Expand $\frac{3+2x}{5+7x}$ into a series by the method of undetermined icients.

Expand $(a^2-x^2)^{-\frac{1}{3}}$ by the binomial formula.

Solve the equation $a^{bx+d}=c$.

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TRIGONOMETRY.

JUNE, 1879.

[State what text-book you have studied and to what extent.]

1. Find the length of an arc of 15° in parts of the radius.

2. Make a table of the algebraic signs of the trigonometrical functions of arcs terminating in each of the four quadrants.

3. Make a table of the values of the functions of 0°, 90°, 180°, 270°.

4. What is the smallest angle that has the same functions as that of 420°? Write equivalent expressions for the following: $\cos(270°-x)$, $\tan(360°-x)$.

5. Given $\sin a = m$, to find all the other functions of a, supposing a an angle of the second quadrant.

6. Show that $\tan(x+45°)+\tan(x-45°)=\frac{4\tan x}{1-\tan^2 x}$.

7. In a right triangle ABC given, A=90°, AB=246.32, AC=380.07, to find the angles B and C and the hypothenuse BC.

8. Explain the method of solving a triangle when two sides and the included angle are given.

TRIGONOMETRY.

SEPTEMBER, 1879.

[State what text-book you have studied and to what extent.]

1. The circular measure of a certain angle is 1.5; find the corresponding number of degrees.

2. Explain the changes in magnitude and sign of the trigonometrical functions of an arc as the arc increases from 0° to 360°.

3. State five fundamental relations which exist between two or more of the trigonometric functions.

5. Deduce the formula $\tan(a\pm b)=\frac{\tan a \pm \tan b}{1 \mp \tan a \tan b}$.

5. Given $\tan(45°-b)+\cot(45°-b)=4$; find tang b and give the corresponding angles if you remember them.

6. A tower stands by a river. A person on the opposite bank finds its elevation to be 60°; he recedes 40 yards in a direct line from the tower and then finds the elevation to be 50°; find the breadth of the river.

7. Deduce the formula $a^2=b^2+c^2-2bc\cos A$, in which a, b, c, are the sides of a triangle and A the angle opposite the side a. What use have you made of this formula, if any?

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LATIN.

JUNE, 1879.

I. Translate as literally as possible—

a. His Caesar ita respondit: Eo sibi minus *dubitationis* dari, quod eas res, quas legati Helvetii commemorassent, memoria teneret; atque *eo* gravius ferre, quo minus *merito* populi Romani accidissent; qui si allicujus injuriae sibi conscius fuisset, non fuisse difficile cavere.

b. Postquam omnes Belgarum copias in unum locum coactas ad se venire vidit, neque jam longe abesse ab his, quos miserat, exploratoribus et ab Remis cognovit, *flumen* Axonam, quod est in extremis Remorum finibus, *exercitum* transducere maturavit, atque ibi castra posuit.

c. Ita commutata fortuna, eos, qui in spem potiundorum *castrorum* venerant, undique circumventos interficiunt et ex *hominum* millibus amplius triginta, quem *numerum* barbarorum ad castra venisse constabat, plus tertia parte interfecta reliquos perterritos in fugam conjiciunt, ac ne in locis quidem superioribus consistere patiuntur.

d. Est autem hoc Gallicae *consuetudinis*, uti et viatores, etiam invitos, consistere cogant, et, quid quisque eorum de quaque re audierit aut cognoverit, quaerant, et *mercatores* in oppidis vulgus circumsistat, quibusque ex regionibus veniant, quasque ibi res cognoverint, pronuntiare cogant.

e. Accedebat huc, quod jam in concilio Aeduorum Dumnorix dixerat, sibi a Caesare regnum civitatis deferri; quod dictum Aedui graviter ferebant, neque *recusandi* aut deprecandi causa legatos ad Caesarem mittere audebant. Id factum ex suis hospitibus Caesar cognoverat.

f. Interim, confecta frumentatione, milites nostri clamorem exaudiunt: praecurrunt equites; quanto sit res in periculo, cognoscunt. Hic vero nulla munitio est, quae perterritos recipiat: modo conscripti atque *usus* militaris imperiti ad tribunum militum centurionesque ora convertunt: quid ab his praecipiatur, exspectant.

II. 1. Decline *minus* (1), *flumen* (8), *locis* (15).

2. Compare *minus* (1), *gravius* (3), *extremis* (9).

3. Write the synopsis, active and passive, of *posuit* (10).

4. State the mood and tense of the following: *commemorassent* (3), *cogant* (18), *circumsistat* (20), *praecipiatur* (32).

5. Give the principal parts of the following: *accidissent* (4), *cavere* (5), *cognovit* (8), *conjiciunt* (15), *patiuntur* (16), *cogant* (18), *audebant* (25), *praecurrunt* (28), *cognoscunt* (29), *perterritos* (29), *convertunt* (31), *praecipiatur* (32).

6. State the construction of all italicized words.

7. Quote from the above text an example of *oratio obliqua.*

8. Convert into *oratio directa* the example quoted in answer to question seventh.

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LATIN.

September, 1879.

I. Translate as literally as possible—

a. Quibus rebus cognitis, quum ad has suspiciones certissimae res accederent, quod per fines Sequanorum Helvetios transduxisset, quod obsides inter eos dandos curasset, quod ea omnia, non modo *injussu* suo et civitatis, sed etiam inscientibus ipsis, fecisset, quod a magistratu Aeduorum accusaretur, satis esse *causae* arbitrabatur, quare in eum aut ipse animadverteret, aut civitatem animavertere juberet.

b. Pro his Divitiacus facit verba: Bellovacos omni *tempore* in fide atque amicitia civitatis Aeduæ fuisse: impulsos a suis principibus, qui dicerent Aeduos a Cæsare in servitutem redactos omnes indignitates contumeliasque perferre, et ab Aeduis defecisse et *populo* Romano bellum intulisse.

c. Quorum *adventu* magna cum auctoritate et magna cum hominum multitudine bellum gerere conantur. Duces vero ii deliguntur, qui una cum Quinto Sertorio omnes *annos* fuerant summamque scientiam rei militaris habere existimabantur. Hi *consuetudine* populi Romani loca capere, castra munire, *commeatibus* nostros intercludere instituunt.

d. Itaque vocatis ad se undique mercatoribus, neque quanta esset insulæ magnitudo, neque quæ aut quantæ nationes incolerent, neque quem usum belli haberent aut quibus *institutis* uterentur, neque qui essent ad majorum navium multitudinem idonei portus, reperire poterat.

e. His rebus cognitis, Cæsar legiones equitatumque revocari atque in itinere resistere jubet, ipse ad naves revertitur: eadem fere, quæ ex nuntiis litterisque cognoverat, coram perspicit, sic ut amissis circiter quadraginta navibus, reliquæ tamen refici posse magno *negotio* viderentur.

f. Magnum ibi numerum versuum ediscere dicuntur: itaque *annos* nonnulli vicenos in disciplina permânent. Neque fas esse existimant ea litteris mandare, quum in reliquis fere rebus, publicis privatisque rationibus, Græcis *litteris* utantur.

II.—1. Decline *obsides* (3), *magistratu* (5), *verba* (8), *majorum* (22).

2. Compare *certissimæ* (1–2), *summam* (16), *majorum* (22).

3. Write the synopsis, active and passive, of *dicerent* (10).

4. State the mood and tense of the following: *accederent* (2), *dicerent* (10), *poterat* (23), *perspicit* (26), *utantur* (32).

5. Give the principal parts of the following: *accederent* (2), *juberet* (7), *redactos* (11), *defecisse* (12), *conantur* (14), *deliguntur* (15), *incolerent* (21), *reperire* (23), *perspicit* (26), *refici* (27), *permanent* (30), *utantur* (32).

6. State the construction of all italicized words.

7. Quote from the above text an example of *oratio obliqua.*

8. Convert into *oratio directa* the example quoted in answer to question seventh.

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LATIN EXERCISES.

JUNE, 1879.

1. The Belgæ[1] are[2] in[3] arms[4].
2. Cæsar ascertains[5] (that) the Belgæ are in arms.
3. Cæsar ascertained (that) the Belgæ were in arms.
4. Cæsar ascertained: "The Belgæ were in arms.
5. The Belgæ drove-out[6] the Gauls.
6. The Gauls were driven-out[7] by the Belgæ.
7. Cæsar inquired what[8] states[9] were in arms.
8. The Belgæ descended[10] from[11] the Germans[12].
9. When[13] Cæsar inquired[14], he ascertained (that) the Belgæ were in arms.
10. When Cæsar had inquired, he ascertained (that) the Belgæ had descended from the Germans.

[1] Belgæ.
[2] esse.
[3] in.
[4] arma.
[5] reperire.
[6] expellere.
[7] ab.
[8] quis.
[9] civitas.
[10] oriri.
[11] ab.
[12] Germani.
[13] quum.
[14] quaerere.

LATIN EXERCISES.

SEPTEMBER, 1879.

1. Cæsar encouraged[1] the minds[2] of the Gauls[3].
2. The minds of the Gauls were encouraged by[4] Cæsar.
3. Cæsar attended to this matter—(*literally*, "this[5] matter[6] was[7] (for) an object-of-attention[8] to Cæsar").
4. Cæsar promised[9] (that) he would attend to this matter.
5. Cæsar promised: "I will attend to this matter."
6. Cæsar had great[10] hope[11] (that) Ariovistus would put-an-end[12] to (his) injuries[13].
7. Cæsar said[14] he had great hope (that) Ariovistus would put an end to (his) injuries.
8. Translate sentence seventh in such a manner as to illustrate direct statement (*oratio directa*).

[1] confirmare.
[2] animus.
[3] Gallus.
[4] ab.
[5] is.
[6] res.
[7] esse.
[8] cura.
[9] polliceri.
[10] magnus.
[11] spes.
[12] finem facere.
[13] injuria.
[14] dicere.

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HISTORY OF THE UNITED STATES.

JUNE, 1879.

1. Describe the settlement of Pennsylvania; state what explorations and settlements were made by the French in North America prior to 1750.

2. When and from whom did the United States acquire Louisiana, Florida, Alaska?

3. Arrange the following events in the order in which they occurred, with their dates: discovery of Gold in California, admission of Vermont to the Union, adoption of the Missouri Compromise, Lee's surrender to Grant, war against Mexico, battle of New Orleans, opening of Pacific Railroad.

4. Tell what you can of Jackson's administration; of Van Buren's.

HISTORY OF THE UNITED STATES.

SEPTEMBER, 1879.

1. When, where and by whom were permanent settlements made in North America prior to 1621?

2. What was the Nullification Act? What was the Embargo Act?

3. Give the contending parties and the (approximate) dates of the following battles: Trenton, Gettysburg, Queenstown, Cerro Gordo, Antietam.

4. Tell what you can of the administrations of John Adams Monroe, Pierce.

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GEOGRAPHY.

JUNE, 1879.

1. Bound the state of Missouri; name three of its largest cities and tell how they are situated; what are the principal rivers in it or on its borders?

2. Describe Lake Michigan; tell what bays or gulfs open into it; what states touch it; and what are the principal cities on its shores?

3. Where does the Columbia River rise, run and empty; and what states, territories and provinces does it touch?

4. What countries or provinces and islands does the Equator cross?

5. Bound France; describe two of its cities; describe two of its rivers.

6. Where are the following cities: Berlin, Buffalo, Belfast, Buenos Ayres, Bremen, Bombay?

GEOGRAPHY.

SEPTEMBER, 1879.

1. Bound the State of Texas; name two of its more important cities and tell how they are situated; what are the principal rivers in it or on its borders?

2. Where does the Potomac River rise, run, and empty; what States does it touch; what are the principal cities on its banks?

3. Describe the Alleghany Mountains, their position and course.

4. What countries does the Tropic of Cancer cross?

5. Where is Russia? tell what seas and gulfs touch its borders; name three of its cities and tell how they are situated; name three of its rivers and tell where they empty.

6. Where are the following places: Milwaukee, Valparaiso, Havre, Damascus, Sydney, Tunis?

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FIFTEENTH ANNUAL REPORT

OF THE

SHEFFIELD SCIENTIFIC SCHOOL

OF

YALE COLLEGE,

1880-81.

PRINTED BY ORDER OF THE GENERAL ASSEMBLY.

NEW HAVEN:
TUTTLE, MOREHOUSE & TAYLOR.
1881.

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State Board of Visitors.

CONSTITUTING, WITH THE SECRETARY OF THE SCHOOL, THE BOARD FOR THE APPOINTMENT OF STATE STUDENTS.

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SECRETARY AND TREASURER OF THE SCHOOL.

GEORGE J. BRUSH.

JANITOR OF SHEFFIELD HALL.

ANTON PFEIFER, 55 Lock street.

JANITOR OF NORTH SHEFFIELD HALL.

GEORGE W. STODDARD, 82 Mansfield street.

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REPORT

OF THE

STATE BOARD OF VISITORS.

To the General Assembly:

The State Board of Visitors of the Sheffield Scientific School have the honor herewith to transmit, for the use of the Legislature, the fifteenth Annual Report of the Governing Board of that institution. Every member of the Legislature will doubtless examine the report sufficiently to learn its general import. It will be seen that the scope of the educational work which is being carried on by this School is substantially the same as for the two or three preceding years. We bear cheerful testimony to the zeal and fidelity with which the entire corps of teachers have discharged their labors. The great value of their work cannot be easily estimated. Nowhere in the State, if in the whole country, are the practical, working sciences, out of which comes the comfort, prosperity and wealth of the New England people, better taught than here.

We call attention to the Horological and Thermometric Bureaus which have been established since the last report.

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The School is in a high state of prosperity; the number of students is largely increased, and there seems a greater desire to obtain the free scholarships.

Intellectual research is extending more and more into those fields where truth can be tested by ordeal. Dogmatism is falling into disfavor and the Experimental Sciences are becoming more popular. These are results which naturally flow from that condition of society in which the largest personal freedom unites with the widest liberty of opinion and the most intrepid spirit of inquiry. The Sheffield Scientific School is the outgrowth of such a condition. Its very existence proves that ours is a free government. Its growing strength and prosperity gives assurance that a free government cannot soon fail. We commend it to the favorable consideration of the General Assembly.

By order of the Board.

CHARLES B. ANDREWS,

Chairman.

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ANNUAL STATEMENT

OF THE

GOVERNING BOARD.

In presenting their Fifteenth Annual Report the Governing Board of the Sheffield Scientific School have no changes of moment to record. The number of students has increased materially over that of the last year: but the future alone can decide whether this is due to accidental causes, or to the reviving interest in scientific studies which owes its origin to the reviving prosperity of the country. In the internal history of this institution there has been but little variation. The courses of instruction can undergo but little alteration, so long as their present means only are at the disposal of the Governing Board, and improvements, which it is desirable to make, must be deferred to a period when the resources of the School have been increased sufficiently to justify their introduction.

It is with regret that the Governing Board are compelled to mention the loss of one of the warmest friends of the School, the Honorable Oliver F. Winchester, who died at his residence in this city, on Friday the tenth of December, 1880. The attention of Mr. Winchester was early directed to the desirability of establishing this department of Yale College on a secure basis, and as far back as 1855 he subscribed five thousand dollars towards the sum which those interested in it were then seeking to raise for its endowment. Nor did his interest so early manifested ever abate, and in recognition of this fact he was made one of the Councillors of the School upon its reorganization in 1869. More recently his regard for science and scientific instruction has been signally manifested by the large gift he made of land to the College for the purpose of founding the observatory, which has been called from his name. Though under special trustees of its own, and therefore not directly connected with the Scientific School, its

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aims are in many respects so alike that its developments and growth must necessarily be attended with more especial benefit to this department than to most of those allied under the name of Yale College.

Winchester Observatory.

Horological and Thermometric Bureaus.

1. The Horological Bureau continues to occupy the room in North Sheffield Hall, which it rents for a computing and clock-room. This room contains, besides a Bond's Chronograph, three standard clocks of the highest grade, mounted on separate piers, in closets with non-conducting walls for protection against sudden changes of temperature. These clocks, together with another in a room near by, and the tower clock of the City Hall (connected electrically with a sounder in the clock room), are compared daily and tested for rate by observations made in the special observatory of the Bureau. From one of these—the standard mean time clock by Howard,—the exact time is regularly distributed by telegraph to various offices in the city and to the chief railroads of the State. The railroads at present thus directly served are the New York, New Haven & Hartford, the Boston & New York Air Line, the Connecticut Western, the Connecticut Valley, and the Naugatuck. Other railroads obtain their time from these.

The standard of time adopted is that of the meridian of the New York City Hall, which is slow of Boston $11^m\ 46^s.3$, and of New Haven (Hor. Obs.) $4^m\ 19^s.58$, and is fast of Washington $12^m\ 10^s.5$.

The City Hall Clock, (a fine one by Howard, with Denison gravity escapement and a three hundred and fifty pound mercurial two-second pendulum,) is connected, as above stated, with the clock room of the Bureau, and proves to be comparable for steadiness of rate with standard astronomical clocks of the first class. Its error is generally less than one second, and is not allowed to exceed two or three seconds at a maximum. Its daily variations of rate are very small fractions of a second. The *first* stroke of the bell marks the precise beginning of each hour—an allowance of course being made for the velocity of sound, of one second for every seventy rods that the observer is distant from the City Hall.

One of the three standard clocks mentioned above was pre-

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sented to the Bureau early in the year by its maker, Dr. William Hillhouse of New Haven, who also gave many years ago the fine transit instrument by Troughton, now used in the Observatory of the Bureau. This clock is of the finest workmanship, has a double three-legged Denison escapement, and a mercurial compensation pendulum of the unusual weight of about sixty-five pounds. Its performance is very satisfactory, though it has not yet been fully investigated.

The testing of fine watches, both for manufacturers and individuals, under the regulations published in the circular of the Bureau, which was given in the last Report, has been successfully carried on during the year at the vaults of the New Haven Safe Deposit Company, where the time pieces are deposited for safe keeping, and where also there is a chronograph electrically connected with the standard mean time clock for facility in rating, as well as the hot and cold closets for testing the effects of temperature.

In May and June a systematic series of telegraphic observations was undertaken on several nights by Dr. Waldo at the Observatory of the Bureau and Prof. Wm. A. Rogers at Harvard College Observatory, for the exact determination of the difference of longitude between these points,—the observers interchanging places on half the evenings to eliminate the effects of personal equation. The Observatory is under obligations to the Director of the Observatory of Harvard College, Professor Pickering, and to the officers of the Western Union Telegraph Company, who have afforded every facility for the successful carrying out of the longitude determination.

The reduction of the observations has not yet been completed, but is well advanced.

Two students in practical astronomy have been employed in the computations and other work of the Bureau during the year.

Neither the time service nor the testing of watches, it may be proper to say, has thus far proved as remunerative as the large cost to the Bureau and the acknowledged benefit of these services to great public and private interests would lead us to expect, yet there is reason to believe that the importance of both is gradually becoming more and more appreciated, and that ultimately they will not fail of an adequate support.

The Time Service, especially, is of vital importance to the railroad interests of the State, and through them to the whole com-

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munity, inasmuch as it promotes safety in the running of trains, and secures in all places accurate and uniform time. It is hoped, therefore, that the Legislature of the State, in view of the great public benefit of this service, will see fit to relieve the observatory of the expense of maintaining it.

Dr. Leonard Waldo is the Astronomer in Charge of the Horological Bureau, and with Mr. William Beebee as assistant, has the entire management of its affairs.

2. The Thermometric Bureau, also in charge of Dr. Waldo, is another branch of service undertaken recently by the Observatory. Its organization and purpose are fully explained in the following published circular, which is here inserted entire.

CIRCULAR CONCERNING THE VERIFICATION OF THERMOMETERS.

This Bureau has been established by the Corporation of Yale College, at the recommendation of the Board of Managers of the Winchester Observatory, in order to afford desired facilities for the adequate verification of thermometers.

Thermometers will be received by the observatory for the purpose of comparison with the observatory standards, and certificates of comparison signed by the Astronomer in charge will be issued with thermometers so compared. These certificates will contain a statement of the corrections to be applied at intervals of five or ten degrees of the thermometer scale to cause it to have the same reading as the observatory standards. In general these corrections will be expressed in tenths of one degree.

Thermometers sent for verification must have a name and number engraved upon them; and thermometers which are not graduated on the glass stem must be of sufficiently good workmanship to satisfy the observer in charge that the scale will not suddenly change with reference to the glass stem of the thermometer tube, with ordinarily careful usage.

The Board of Managers have established the following scale of charges for this service, which includes certificate:—

Standard Meteorological Thermometers with independent freezing point determination,	$2.00
Standard Meteorological Thermometers,	1.00
Ordinary Meteorological Thermometers,	.50
Ordinary Maximum Thermometers,	.75
Ordinary Minimum Thermometers,	.75
Clinical Thermometers,	.50

There will be a deduction of one-fifth of the above charges where more than eight thermometers of one kind are received at the same time. In the case of clinical thermometers the charge will be four dollars per dozen when not less than two dozen are sent at the same time.

For other thermometers than the above the charges for verification will be furnished on application.

The letter of advice accompanying thermometers sent for verification should

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contain the maker's name, the number of each thermometer, and full directions for reshipment.

All proper precautions are taken by the Board of Managers to guard against loss or injury; but as it is manifestly inexpedient that a University Corporation should be responsible for property in its care for such a purpose, it is to be understood that all risks are assumed by the person sending the thermometers.

LEONARD WALDO,
Astronomer in Charge.

Approved and ordered to be published by the Board of Managers of the Winchester Observatory.

C. S. LYMAN, *President.* H. A. NEWTON, *Secretary.*

New Haven, Conn., June 1, 1880.

Statistics show that several thousand thermometers of refined construction, and graduated on the stem to 0°.2 F. or thereabouts, are annually procured by the medical practitioners of our country alone for physiological researches and daily practice. The majority of these thermometers are newly made (within six months), and their verification depends on inferior (from the scientific standpoint) thermometers in the hands of individual makers. It is needless to say that the readings of such thermometers have little value in indicating the true temperature of a patient, or affording data in cases which the physician wishes to describe in print.

The makers of thermometers in our country have been in general content to use for their standards, thermometers which have not been recently compared at a foreign observatory or with some more easily accessible instrument in which they place confidence, in the hands of a friendly neighbor. Thus it happens that many thousand American clinical thermometers have been sold, which do not depend upon a comparision with a recognized standard for their scale readings. The result has been that the American instruments have suffered in the estimation of scientific practitioners. This is not so much the fault of the American makers as their misfortune in not having the same facilities offered them by the properly equipped observatories this side of the water, which their favored competitors enjoy abroad.

The meteorological observers in this country have now no common standard of easy access; and it seems eminently proper that the observatory should undertake to be useful to the medical profession and the meteorologists in this country, and afford the means of comparison desired. With this end in view, the observatory has accepted the aid of the Board of Directors of the Bache Fund of the National Academy in obtaining the standards of the foreign observatories, and has made provision for the constant determination of the errors of the standards themselves.

In order to encourage the manufacture of thoroughly seasoned thermometers for physicians' use, the observatory will receive from the makers thermometer tubes which have been numbered but not graduated, and will seal such tubes in

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boxes in such a manner that they can only be opened by breaking the seals. After not less than one year the boxes may be opened by an observatory officer, and in the certificates of verification furnished with these thermometers the length of time they have been under the observatory seal will be stated. The observatory charge for recording and sealing such thermometers will be $1.00 per hundred, and makers desiring to avail themselves of this privilege will send such boxes to the observatory for sealing.

The observatory will make arrangements with hospitals and other institutions using a number of thermometers, for the systematic examination at stated intervals of all thermometers in their use. Such an arrangement precludes errors arising from the use of newly made instruments which have been verified, but whose scales have not yet attained an approximately permanent position.

Ordinary and clinical thermometers are returned within three days from the time of their reception, if the observatory charges for verification are remitted with the thermometers.

In case they are not so remitted, they are payable upon notification by the observarory that the thermometers are ready to be returned.

Dealers and manufacturers furnishing satisfactory references to the observatory may open an account, to be settled quarterly, beginning with January 1 of each year.

The Thermometric Bureau is under the immediate charge of Dr. Leonard Waldo. The observatory also receives the advice of Professor J. Willard Gibbs and Professor Arthur W. Wright in regard to problems connected with thermometry.

NOTICE.

To insure the safe transmission of thermometers by express, they should be packed in two boxes, one inside the other, and the space filled with cotton-wool or its equivalent. Single clinical thermometers may be packed in wooden boxes and sent by mail. New York makers desiring to send thermometers by hand may do so by leaving them with Lockwood's private express, care Oelschlaeger Bros., 162 William Street. The P. O. Address of the Observatory is Box 853. The Office is at 89 Orange Street, to which all packages may be directed.

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The following standards will be used by this department of the Observatory for the verification of thermometers:—

Designation.	Maker.	Maker's Number.	How Graduated.	Length of 1°.	Smallest Graduation.	Length of Tube.	Shape of Bulb.	Remarks.
Standard Air Thermometer.								**
Primary Standard.	Kew Observatory.	585	−34° to +275° C.	1.73 mm.	1°	618 mm.	Cylindrical.	Kew Observatory, 1880. Filled in 1867.
" "	Kew Observatory.	578	− 9 to +105 C.	3.46 "	0.5	455 "	"	Kew Observatory, 1880. Filled in 1868.
" "	Kew Observatory.	584	+14 to +220 F.	1.97 "	1	455 "	"	Kew Observatory, 1880. Filled in 1868.
" "	Casella, London.	35247	+30 to +214 F.	1.88 "	1	390 "	"	Filled in 1867, Graduated 1879.
" "	R. Fuess, Berlin.	89	− 6 to +105 C.	4.15 "	0.1	650 "	"	Patent, 1877.
" "	R. Fuess, Berlin.	50	− 2 to +105 C.	4.05 "	0.2	573 "	"	Patent, 1877.
" " (Five).	Baudin, Paris.		C.		0.1 and 0.2			**
" "	Fastré Ainé à Paris.	*594	−18 to +85.6 C.	3.62 "	*	550 "	"	Filled in 1854.
" "	Fastré Ainé à Paris.	*596	−35 to +84.2 C.	2.60 "	*	508 "	"	" 1854.
Four Standards.	Tonnelot à Paris.	2584 to 2587	+ 5 to +230 F.	1. 8 "	0.5	455 "	"	" 1879-4.
Secondary Standard.	Casella, London.	35242	+10 to +215 F.	1.59 "	1	378 "	"	Filled in 1867. Graduated 1879.
" "	Casella, London.	35246	+27 to +212 F.	1.85 "	1	382 "	"	Filled in 1867. Graduated 1879.
" "	Fuess, Berlin.	596 b.	−24 to + 55 C.	2.44 "	0.2	302 "	Spherical.	
" "	Greiner & Geissler, Berlin.	601	−19 to + 45 C.	3.94 "	0.2	245 "	"	Date 1873 on the Scale.
" "	Greiner & Geissler, Berlin.	508	−27 to + 50 C.		0.2	298 "	"	
" "	F. G. Greiner.	600	− 1 to + 27 R.	9.50 "	0.1	418 "	Cylindrical.	Date 1852 on the Scale.
" " (Two).	Baudin, Paris.		F.		0.5			**
Comparison Thermometers.								
Twenty-Five.	Alvergniat Freres.							**
Six.	Casella, London.	Various Numbers.	−20 to +188 F.	about 1.7 mm.	1	200 "	Spherical.	
One.	Fuess, Berlin.	59	− 8 to +105 C.	2.27 "	1	299 "	Cylindrical.	
——	Baudin, Paris.							**
Clinical Thermometers.								
Four.	Alvergniat Freres.							**
Four.	Casella, London.	Various Numbers.	+80 to +130 F.	about 3.5 "	0.2	258 "	Cylindrical.	
Two.	Fuess, Berlin.	84 and 85	+26 to + 46 C.	about 7.2 "	0.1	288 "	"	
Self-Registering Thermometer.	Casella, London.	9738	−15 to +135 F.	1.69 "	1	306 "	Spherical.	Maximum.
" " "	Casella, London.	9930	−25 to +120 F.	1.66 "	1	337 "	"	Minimum (spirit).

Besides these there are some twenty-five thermometers, by various reputable makers, self-registering and otherwise, to be used as occasion requires.

* Loaned from the Physical Laboratory by Professor Arthur W. Wright. Arbitrary graduations. ** Not yet received.

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The following pieces of apparatus are also in use in the thermometric work:

1. A Crouch microscope comparator. 2. A pair of microscopes provided with eye-piece micrometers, and objectives of four inch equivalent foci by Beck. 3. A small vertical cathetometer by Wm. Grunow, graduated to single millimeters, the vertical motion being 220^{mm} and the telescope having an eye-piece micrometer by Rogers. 4. A superior standard barometer, "Jas. Green, N. Y., 957," with half-inch mercury column and reading to 0.001 inches. 5. A freezing-point apparatus of two liters capacity, consisting of a tinned iron vessel within another, the space between them filled with cotton-wool. 6. A boiling-point apparatus constructed of brass after the plan of Regnault. 7. An improved boiling-point apparatus constructed entirely of glass. 8. An elaborate apparatus of brass for accurately and rapidly comparing clinical thermometers, in a suitable water bath.

Six hundred thermometers have already been carefully tested in the few months since the work was commenced, and the constantly increasing demand for this service gives promise that it will prove highly beneficial alike to the medical profession and to the science of the country.

Public Lectures.

The fourteenth annual course of lectures to mechanics and others was given during the past year in the lecture room in North Sheffield Hall. The lecturers and the subjects are indicated in the following program:

I.	Thursday, Feb.	5.—Hybridism.	Prof. Daniel C. Eaton.
II.	Tuesday, "	10.—Christian Iconography; illustrated from Amiens Cathedral.	Prof. D. Cady Eaton.
III.	Thursday, "	12.—Dogs.	Prof. Brewer.
IV.	Tuesday, "	17.—The Heroic Element in Historical Persons and Eras.	Prof. Fisher.
V.	Thursday, "	19.—The Story of a Light House.	Prof. DuBois.
VI.	Tuesday, "	24.—Telling the Time.	Dr. L. Waldo.
VII.	Thursday, "	26.—Adulteration of Foods.	Prof. Johnson.
VIII.	Tuesday, Mar.	2.—Nutrition.	Mr. R. H Chittenden.
IX.	Thursday, "	4.—The Culture and Preparation of Tea.	Prof. S. Wells Williams.
X.	Tuesday, "	9.—Fundamental Ideas in Mechanics.	Dr. Skinner.
XI.	Thursday, "	11.—The Giant Cephalopods or "Devil-fish" of the North Atlantic.	Prof. Verrill.
XII.	Tuesday, "	16.—Modern Sanitary Science.	Prof. Brewer.

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Lectures on Military Science.

A course of Lectures on Military Science, by officers of the U. S. Engineering School, at Willet's Point, was delivered in North Sheffield Hall as a part of the instruction in the School during the second term of the academic year 1879–80. The order and subjects of the Lectures were as follows:

I.	Monday, Feb. 23.—Strategy and Grand Tactics.	Lieut. G. McC. Derby, U. S. Engineers.
II.	Friday, " 27.—Logistics.	Lieut. James L. Lusk, U. S. Engineers.
III.	Monday, Mar. 1.—Small Arms and their influence on Tactics.	Lieut. W. M. Black, U. S. Engineers.
IV.	Friday, " 5.—Artillery.	Capt. J. B. Quinn, U. S. Engineers.
V.	Monday, " 8.—Fortification.	Capt. A. M. Miller, U. S. Engineers.
VI.	Friday, " 12.—Torpedoes.	General H. L. Abbot, U. S. Engineers.

Additions to the Zoological Collections.

A. E. Verrill, Curator; J. H. Emerton, Assistant.

During the past year the most important of the additions to the Zoological collections have been due to the coöperation of the curator with the U. S. Fish Commission, as in previous years, in the exploration of the sea-bottom along our coasts.

The head-quarters of the Commission were at Newport, R. I., this season, and the dredging and trawling was carried on from that point over a wide area, both in the shallower waters and southward to the distant banks, from 70 to 115 miles off shore, and to a depth of 500 fathoms, with very great success.

This year the new steamer "Fish Hawk," of 480 tons, built and fitted expressly for the scientific work of the Fish Commission, was employed in these explorations. The commander, Lieut. Z. L. Tanner, U. S. N., also made another trip, after the regular work of the season was over, to the deep-water off the mouth of Chesapeake Bay, with excellent results. The very extensive and valuable series of Invertebrata, obtained during these explorations, as well as numerous collections contributed to the Fish Commission by the bank fishermen of Gloucester, Mass., have all been sent to the Museum to be elaborated and reported upon, and eventually to be distributed.

Mr. A. Agassiz has sent to the curator and Professor S. I. Smith, for elaboration, the Cephalopoda, Crustacea and Anthozoa obtained by him while exploring the bottom beneath the Gulf Stream, along the U. S. Coast, this season, on the Coast Survey steamer "Blake."

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These several collections are not only very large and interesting, but they contain large numbers of genera and species wholly unknown before, as well as very many others that are new to our coast.

In these explorations, this season, the curator was assisted especially by Mr. Richard Rathbun, Mr. Sanderson Smith, and Mr. J. H. Emerton. Messrs. B. F. Koons and E. A. Andrews of this School, also joined our party, and were very useful assistants.

Professor S. I. Smith has, as usual, taken charge of the Crustacea, and has very thoroughly revised the Decapoda of northern New England. He has prepared for publication in the Proceedings of the National Museum accounts of the numerous new and strange forms of Crustacea obtained in deep-water, off our coast. He has also revised certain groups of the Amphipoda, and printed the results in the Transactions of the Connecticut Academy, Vol. IV. Mr. Oscar Harger has printed in the report of the U. S. Commissioner of Fish and Fisheries, an extended monograph of the Isopoda of New England, upon which he has for several years been engaged. Mr. E. B. Wilson has printed, in the same report, his monograph of the Pycnogonida of New England. The curator has published, in the Trans. Conn. Acad., Vol. V., the first part of a monograph of the New England Cephalopoda, including all the gigantic species hitherto discovered; the second part of this work is now printing. He has also printed more or less detailed accounts of the most interesting forms of Mollusca and Echinoderms obtained in deep-water off our coast, in the American Journal of Science, and in the Proceedings of the National Museum. These several reports are all based on specimens in the Yale Museum, and are profusely illustrated. They represent an important part of the scientific work done in the Museum during the past and previous years. Mr. J. H. Emerton, in addition to his ordinary duties, has made large numbers of excellent drawings to illustrate some of the reports referred to above, and for others now in progress.

Mr. Sanderson Smith and Mr. Richard Rathbun have been employed in the Museum during a part of the year, at the expense of the U. S. Fish Commission, to aid the curator in working up the large amount of material that has accumulated in our storerooms.

Miss K. J. Bush has been employed in completing and copying the permanent catalogues, in writing labels for those

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specimens that are on exhibition, and in other clerical duties. Her work has been done very carefully and is, in all respects, highly satisfactory. Mr. E. H. Hawley, during the first part of the year, continued the mounting of the specimens of shells and other invertebrates in the Museum. But this work has been discontinued for want of funds.

Aside from the large collections of the U. S. Fish Commission, referred to above, the following have been received:

Gardiner Morse, Jr., *Gammarus fasciatus*, Mumford, N. Y.

Robt. T. Morris, living puffing adder.

Edw. E. Brewster (S. S. S. 1878), nest and eggs of woodcock, Cornwall, Conn., collected April 24, 1879.

Mrs. M. C. Reid, New Haven, a starfish (*Asterias Forbesii*), with eight arms (a monstrosity), from Bridgeport.

Publishers of Evening Register, New Haven, an ermine, collected by Fred. Hotchkiss, in Woodbridge.

C. W. Canfield (S. S. S. 1878), eggs of *Rana sylvatica*, taken March 13, at Westerly, R. I.

Col. G. L. Febiger, rare land shells, from Louisiana.

Capt. Davis, Stony Creek, squilla and young lobster.

Mrs. E. A. Brown, barnacles from bottom of vessel.

Geo. W. Potter, E. Haven, living copper-head snake (*Ancistrodon contortrix*), and two living black snakes, East Haven.

Adrian Ohule, living puffing adder.

Wm. G. Daggett (Y. C.), living snapping turtle.

O. W. Atwater, living water-snake (*Tropidonotus sipedon*).

B. F. Koons (S. S. S.), eggs of wood turtle (*Glyptemys insculpta*), and spotted turtle (*Nanemys guttata*), New Haven.

C. M. Crouse (S. S. S.), living striped snake and two moles (*Scalops aquaticus*), from New Haven; craw-fish, Central New York.

E. V. Reynolds (S. S. S.), a miscellaneous collection, from New Haven, from Nassau, W. I., etc.

Prof. A. E. Verrill, brown snake (*Storeria Dekayi*); milk-snake (*Ophiobolus*); nest and eggs of vireo; large fiddler-crabs (*Gelasimus minax*), Annelids, etc., from New Haven.

E. A. Andrews (S. S. S.), spotted turtles (*Nanemys guttata*), New Haven.

R. C. Ballard (S. S. S.), collection of fossils.

James Snedeker, New Haven, a wood turtle (*Glyptemys insculpta*), and nest with eggs of marsh wren.

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C. D. Hall, orange file-fish, from Madison.

W. F. Lane, Wallingford, little auk (*Mergulus alle*), from Guilford.

J. H. Emerton, a mole (*Scolaps aquaticus*), New Haven; nudibranch mollusca from Salem, Mass.

Horace Bowman, New Haven, cluster of oysters on a living quahog clam, orange file-fish, rudder-fish, and other fishes, New Haven.

John G. Brady (Y. C. 1874), sea-pen (*Verrillia Blakei*), from Alaska.

Samuel W. Williston, a valuable collection of named Diptera from Connecticut and California; rare birds' eggs, from Rocky Mountains.

John Pardee, living alligator from Florida.

R. S. Griswold, living alligator from Florida.

Josephus Rice, salamanders (*Desmognathus fucus*), from North Haven.

Adam Herman, New Haven, star-nosed mole, mounted, and monstrous frog, with double hind legs.

W. J. Comstock (S. S. S. 1879), toad from Hamilton Inlet, Labrador.

Prof. E. S. Dana, snakes from St. Johns River, Florida.

Prof. J. K. Thacher, larvæ of lamprey eel.

Richard Westbrook, hoary bat (*Lasiurus cinereus*), from New Haven.

National Museum, Washington, D. C., coach-whip snake and king-snake, from Florida.

Mrs. Chas. Ives, New Haven, several sponges and a rare coral (*Eusmilia*), from Nassau.

John Booth, New Haven, monstrous flask-shaped hen's egg.

Anonymous. Red-throated diver, mounted, from Alabama.

Small collections of insects have been received from S. B. Cocks, W. Van Name, Forest Shepard, F. S. Smith, Dr. H. Van Hoosear, Geo. B. Lobdell, Jr., and others.

Anniversary.

The Exercises of the Graduating Class were held in North Sheffield Hall on the evening of Tuesday, June 29, 1880. The candidates for degrees with the subjects of their graduation theses are given in the following schedule. Those marked with an asterisk were read in the evening.

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CIVIL ENGINEERS. (3)

DWIGHT EDWARD PIERCE, Ph.B., *South Bethlehem, Pa.* Design for an Iron Railroad Bridge.

EBEN JENNINGS WARD, Ph.B., *Marseilles, Ill.* A Review of the Glascow Steel Bridge.

DYNAMIC ENGINEER. (1)

AUGUSTUS JAMES EMERY, Ph.B., *Bangor, Me.* The More Important Principles which should Govern the Design and Construction of the Steam Engine.

BACHELORS OF PHILOSOPHY. (42)

DANIEL SYDNEY APPLETON (Select), *New York City.* On the United States Life-Saving Service.

CHARLES RUFUS AYRES (Select), *Woodmont.* On Agricultural Underdrainage.

CHARLES BACKUS BALL (Civil Engineering), *New Haven.* On the American Engineering Contract System.

ROGERS CLARK BALLARD (Chemistry), *Louisville, Ky.* A Method of Analysis for the Lead Furnace Slags.

HARRY BANNING BRADFORD (Dynamic Engineering), *Wilmington, Del.* On the Determination of the Mechanical Equivalent of Heat.

*HARRY OSBORN CARRINGTON (Dynamic Engineering), *New Haven.* On the Steam Injector.

JOSEPH ARTHUR CHANUTE (Chemistry), *New York City.* On Thomas and Gilchrist's Process for Dephosphorizing Iron.

GEORGE HUNTINGTON CLARK (Civil Engineering), *Norwich.* A Review of the Magnetic Iron Ore Mines of Morris County, N. J.

ARTHUR BAYLIES COFFIN (Biology), *Edgartown, Mass.* On the Circulatory System of the Dog.

EDWARD ALLEN COLBY (Chemistry), *St. Johnsbury, Vt.* On the Separation of Manganese from Calcium and Magnesium.

*FRANK MCALPINE COLLIN (Select), *Penn Yan, N. Y.* On the Tenure of Land in Ireland.

CHARLES MABIE CROUSE (Natural History), *Syracuse, N. Y.* On the Structure of *Scolopendrium vulgare.*

CHARLES THOMPSON DOLD (Dynamic Engineering), *West Meriden.* On Fuel and its Combustion in relation to Steam Boilers.

ARTHUR DODGE (Dynamic Engineering), *Stamford.* On Superheated Steam.

THOMAS EDWARD DOOLITTLE (Biology), *Onarga, Ill.* On the Circulatory System of the Shad.

JACOB EDWARD EMERY (Select), *Fair Haven.* On the Acquisition and Distribution of the Public Lands of the United States.

*GEORGE EDWARD GOODSPEED (Select), *East Haddam.* On the Population of the United States.

JOHN WARREN HARDENBERGH (Civil Engineering), *Jersey City, N. J.* A Review of the Metropolitan Elevated Railroad.

LOUIS MAYNARD HIGGINSON (Select), *Newburgh, N. Y.* On the Contributions of Professor Cairnes to Political Economy.

*WALTER HITCHCOCK (Biology), *Cheshire.* On the Nervous System of *Diemictylus viridescens.*

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THEODORE LANAHAN HOOPER (Dynamic Engineering), *Baltimore, Md.* A Discussion of Slide Valves by means of Zeuner's Valve Diagrams.

COLIN MACRAE INGERSOLL (Dynamic Engineering), *New Haven.* On the Trowbridge-Mather Automatic Boiler.

MARTIN EDWARD JENSEN (Chemistry), *Cleveland, O.* Analysis of Cymatolite.

*DAVID BROWN LEWIS (Civil Engineering), *Utica, N. Y.* On the Belgian System of Cable-Towing as used on the Erie Canal.

ERNEST THEOPHILUS LIEFELD (Select), *New Haven.* On the Treatment of Criminals.

*WILLEY SOLON MCCREA (Select), *Chicago, Ill.* On the Problem of Transportation.

JOHN MOORHEAD (Chemistry), *Pittsburg, Pa.* On the Best Volumetric Methods of Determining Iron.

*CARL EUGENE MUNGER (Biology), *Watertown.* On the Digestive System of *Bascanion constrictor.*

EDWARD BUTLER NEEDHAM (Biology), *Hartford.* On the Respiration of the Frog (*Rana fontinalis*).

GEORGE BENJAMIN PHELPS (Biology), *Watertown, N. Y.* On the Rate of Elimination of Arsenic by the Kidneys.

*DWIGHT PORTER (Civil Engineering), *Hartford.* On Storage Reservoir, No. 2, at Farmington, Conn.

EDWARD FREEMAN PORTER (Select), *Stowe, Vt.* On the Effect of Machinery on Wages.

EDWARD VILETTE REYNOLDS (Natural History), *Chicago, Ill.* On the Appendages of the Hermit Crab (*Eupagurus pollicaris*).

*EDWIN MCNEIL ROGERS (Dynamic Engineering), *Central City, Col.* Design for a Gravity Road.

GEORGE BLISS ROGERS (Select), *Lexington, Mass.* On Rent.

EDWARD RUPERT SARGENT (Select), *New Haven.* On the Panic of 1873.

WILLIAM BARTLETT SCHOFIELD (Dynamic Engineering), *West Point, N. Y.* On the History of the Locomotive Steam Engine.

HENRY STARKWEATHER (Dynamic Engineering), *New Haven.* On the Value of the Condenser in the Economy of Fuel.

ADRIAN ROWE WADSWORTH (Civil Engineering), *Farmington.* On the Hartford Sewage System.

WILLIAM CANDEE WARREN (Select), *Buffalo, N. Y.* On the Signal Service of the United States.

ADOLPH FREDERIC WEHNER (Dynamic Engineering), *New Haven.* On the Magneto-Electric Machine.

GEORGE GOODWIN WILLIAMS (Select), *Glastonbury.* On the Suppression of the Theater during the Reign of Charles I.

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Prizes.

The following prizes were awarded during the year:

CLASS OF 1880.

For excellence in German, the prize awarded to Frank McAlpine Collin, with honorable mention of George Huntington Clark and Ernest Theophilus Liefeld.

For excellence in French, the prize awarded to Dwight Porter.

For excellence in Civil Engineering, the prize awarded to Dwight Porter.

CLASS OF 1881.

For excellence in the Mathematics of Junior Year, the prize awarded to William Meeker Wood, with honorable mention of George Frederick Bosworth, Jeme Tien Yow, and Willis Benton Wright.

CLASS OF 1882.

For excellence in all the Studies of Freshman Year, the prize divided between Harry Weir Casey and Frank Judson Lambert.

For excellence in German, the prize divided between Frederick William LaForge and Norman Smith Latham, with honorable mention of Kee Yung Chun.

For excellence in Mathematics, the prize divided between Harry Weir Casey and Frank Judson Lambert.

For excellence in Physics, the prize awarded to Harry Weir Casey.

For excellence in Chemistry, the prize awarded to Frank Judson Lambert.

For excellence in Descriptive Geometry, the prize divided between Harry Weir Casey and Frank Judson Lambert.

For excellence in English Composition, first prizes awarded to Henry Jonathan Biddle, Harry Weir Casey, James John Drummond, Robert Ogden Dubois, Frederick William LaForge, and Sheldon Elton Minor; second prizes to Nathan Gross Bozeman, Alexander Bryan Johnson, Norman Smith Latham, and Lewis Valentine Pirsson.

CLASS OF 1883.

For the best Entrance Examination, the prize awarded to John Alpheus Allen, *New Haven*. Prepared at the Hillhouse High School, New Haven.

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PROGRAMME OF STUDIES,

AND

CATALOGUE,

FOR THE COLLEGE YEAR 1880-81.

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CALENDAR.

1880.		
16 Sept.	Thursday,	First Term begins.
23 Dec.	Thursday,	First Term ends.
1881.		**Winter Vacation of three weeks.**
13 Jan.	Thursday,	Second Term begins.
13 April,	Wednesday,	Spring Recess begins.
20 April,	Wednesday,	Spring Recess ends.
28 June,	Tuesday,	Meeting of Appointing Board
28 June,	Tuesday,	Anniversary.
29 June,	Wednesday,	Commencement.
30 June,	Thursday,	Examination for Admission.
1, 2 July,	Friday, Sat.,	
		Summer Vacation of eleven weeks.
13, 14 Sept.	Tues., Wedn.,	Examination for Admission.
15 Sept.	Thursday,	First Term begins.
22 Dec.	Thursday,	First Term ends.

ABBREVIATIONS.

S. H.	Sheffield Hall.
N. S. H.	North Sheffield Hall.
TR.	Treasury Building.
D.	Durfee College.
F.	Farnam College.
E.	East Divinity Hall.
W.	West Divinity Hall.
P. M.	Peabody Museum.
A.	Absent on leave.

In the buildings belonging to the Sheffield Scientific School, the rooms numbered from 1 to 21 are in Sheffield Hall; from 26 to 58 in North Sheffield Hall.

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CORPORATION.

PRESIDENT.

REV. NOAH PORTER, D.D., LL.D.

FELLOWS.

HIS EXCELLENCY CHARLES B. ANDREWS, LL.D., LITCHFIELD.

HIS HONOR DAVID GALLUP, PLAINFIELD.

REV. LEONARD BACON, D.D., LL.D., NEW HAVEN.

REV. THEODORE D. WOOLSEY, D.D., LL.D., NEW HAVEN.

REV. HIRAM P. ARMS, D.D., NORWICH TOWN.

REV. GEORGE J. TILLOTSON, M.A., WETHERSFIELD.

HON. ALPHONSO TAFT, LL.D., CINCINNATI, O.

REV. AMOS S. CHESEBROUGH, M.A., DURHAM.

REV. MYRON N. MORRIS, M.A., WEST HARTFORD.

HON. WILLIAM M. EVARTS, LL.D., NEW YORK CITY.

HON. WILLIAM B. WASHBURN, LL.D., GREENFIELD, MASS.

REV. SAMUEL G. WILLARD, M.A., COLCHESTER.

HON. HENRY B. HARRISON, M.A., NEW HAVEN.

REV. JOSEPH W. BACKUS, M.A. ROCKVILLE.

REV. CHARLES RAY PALMER, M.A., BRIDGEPORT.

REV. JOSEPH H. TWICHELL, B.A., HARTFORD.

HON. WILLIAM WALTER PHELPS, M.A., NEW YORK CITY.

MASON YOUNG, M.A., NEW YORK CITY.

SECRETARY.

FRANKLIN B. DEXTER, M.A.

TREASURER.

HENRY C. KINGSLEY, M.A. (5 TR.) 23 Hillhouse av.

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GOVERNING BOARD.

APPOINTED BY THE CORPORATION OF YALE COLLEGE.

President.

REV. NOAH PORTER, D.D., LL.D., (7 TR.) 31 Hillhouse av.

Chairman and Executive Officer.

GEORGE J. BRUSH, (3 S. H.) 14 Trumbull st.

Professors.

ARRANGED IN THE ORDER OF THEIR GRADUATION.

WILLIAM A. NORTON,
Civil Engineering. (34 N. S. H.) 72 Prospect st.

CHESTER S. LYMAN,
Physics and Astronomy, Theoretical and Practical. (39 N. S. H.) 88 Trumbull st.

WILLIAM D. WHITNEY,
Linguistics and French. (205 D.) 246 Church st.

GEORGE J. BRUSH,
Mineralogy. (3 S. H.) 14 Trumbull st.

SAMUEL W. JOHNSON,
Theoretical and Agricultural Chemistry. (12 S. H.) 54 Trumbull st.

WILLIAM H. BREWER,
Agriculture (NORTON *Professor*). (4 S. H.) 246 Orange st.

JOHN E. CLARK,
Mathematics. 29 Eld st.

DANIEL C. EATON,
Botany. (41 N. S. H.) 70 Sachem st.

THOMAS R. LOUNSBURY,
English. 22 Lincoln st.

FRANCIS A. WALKER,
Political Economy and History. 68 Whitney av.

OSCAR D. ALLEN,
Analytical Chemistry and Metallurgy. (13 S. H.) 189 Temple st.

ADDISON E. VERRILL,
Zoölogy and Geology. (15 P. M.) 148 College st.

SIDNEY I. SMITH,
Comparative Anatomy. (14 P. M.) 148 College st.

WILLIAM G. MIXTER,
Chemistry. (8 S. H.) 8 Trumbull st.

A. JAY DUBOIS,
Dynamical Engineering (HIGGIN *Professor*). (45 N. S. H.) 328 Howard av.

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LECTURERS, INSTRUCTORS AND ASSISTANTS

ADDITIONAL TO THE GOVERNING BOARD.

ALBERT S. WHEELER,
German. 27 Eld st.

MARK BAILEY,
Elocution. (105 F.) 200 Temple st.

JOHN H. NIEMEYER, Professor in Yale School of Fine Arts,
Free Hand Drawing. 8 Art School.

FREDERICK R. HONEY,
Descriptive Geometry and Projection Drawing. (53 N. S. H.) 14 Lincoln st.

JOSEPH J. SKINNER,
Mathematics and French. 176 York st.

JOSEPH F. KLEIN,
Kinematics and Machine Design. (45 N. S. H.) 14 Whalley av.

GEORGE W. HAWES,
Mineralogy and Lithology. (2 P. M.) 116 High st.

JAMES F. COLBY,
Political Economy. Room 10, 179 Church st.

ALLEN B. HOWE,
Analytical Chemistry. 138 College st.

RUSSELL H. CHITTENDEN,
Physiological Chemistry. (13 S. H.) 95 Humphrey st.

WILLIAM J. COMSTOCK,
Analytical Chemistry. 167 Crown st.

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GRADUATE STUDENTS.

Otis Elihu Atwater, B.A.	*Brattleboro, Vt.*	34 S. M.
Rogers Clark Ballard, PH.B.	*Louisville, Ky.*	92 W.
John Pomeroy Bartlett, PH.B.	*New Britain,*	16 S. H.
Harry Lane Bruner, B.A. Abingdon College.	*Abingdon, Ill.*	169 Temple st.
Charles Sumner Burt, U.S. Military Academy, West Point.	*Marquette, Mich.*	114 College st.
Henry Osborn Carrington, PH.B.	*New Haven,*	527 Chapel st.
William James Comstock, PH.B.	*Toledo, O.*	167 Crown st.
John Edward Cromwell, PH.B.	*Cranford, N. Y.*	6½ York sq.
Henry Allen Hazen, M.A. Dartmouth College.	*New Haven,*	298 Chapel st.
William Hale Herrick, M.A. Williams College.	*Grinnell, Iowa,*	90 Whalley av.
Alfred Edwards Hooker, B.A.	*New Haven,*	62 Prospect st.
William Forest Hutchison, B.A.	*Norwich,*	464 Chapel st.
Colin Macrae Ingersoll, PH.B.	*New Haven,*	85 Trumbull st.
Joseph Frederick Klein, D.E.	*New Haven,*	14 Whalley av.
Benjamin Franklin Koons, B.A. Oberlin College.	*Sulphur Springs, O.*	36 Court st.
Samuel Waldron Lambert, B.A.	*New York City,*	90 High st.
Calvin McCormick, B.A. Franklin College, Ind.	*Franklin, Ind.*	215 York st.
Dwight Porter, PH.B.	*Hartford,*	14 S. H.
Frederick Sumner Smith, B.A.	*New Haven,*	78 Trumbull st.
Heman Bangs Smith, M.D.	*Westville,*	Westville.

GRADUATE STUDENTS, 20.

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SENIOR CLASS.

Charles Francis Adams,	*Jessups, Md.*	36 Elm st.
Ethan Allen Andrews,	*Tarrytown, N. Y.*	175 Temple st.
Edward Bailey, Jr.,	*Harrisburg, Pa.*	489 Chapel st.
Frank Lewis Bigelow,	*New Haven,*	278 Orange st.
George Frederick Bosworth,	*Milford.*	94 Olive st.
Lester Paige Breckenridge,	*Westfield, Mass.*	6½ York sq.
Charles Sheldon Burnham,	*Woodbridge,*	Watson st.
Charles Monroe Carpenter, Jr.,	*Brooklyn, N. Y.*	134 College st.
Howard Field Chappell,	*Chicago, Ill.*	36 Elm st.
George Strong Daniels,	*New York City,*	73 w.
Charles Manville Downs,	*New Haven,*	70 Wooster st.
John Slade Ely,	*New York City,*	71 w.
George Sherman Folsom,	*Northford,*	161 George st.
Seymour Francis Frasick,	*Hartford,*	99 Wall st.
Albert Moses Gerstle,	*Youngstown, O.*	6 Orange st.
Henry Holbrook Gladding,	*New Haven,*	170 Martin st.
William Loomis Griswold,	*Banksville,*	173 Whalley av.
Frederic Jonathan Hiller,	*Cohoes, N. Y.*	71 w.
Samuel Higgins,	*Buffalo, N. Y.*	85 w.
Blain Jamison,	*New Orleans, La.*	489 Chapel st.
Jeme Tien Yow,	*Canton, China,*	44 Elm st.
Edmund Parker Lord,	*Saxonville, Mass.*	86 w.
Richard Becker Lyon,	*New Haven,*	710 Chapel st.
Silas Metzger,	*New Haven,*	17 Grove st.
Edwin Kirtland Morse,	*Poland, O.*	49 Crown st.
Marcus Daty Munn,	*Southington,*	173 Whalley av.
Marvin Olcott,	*Corning, N. Y.*	86 w.
Owyang Keng,	*Canton, China,*	169 Temple st.
Francis Stuyvesant Peabody,	*Chicago, Ill.*	36 Elm st.
Oliver Phelps,	*Canandaigua, N. Y.*	92 w.
Addison Alexander Righter,	*Newark, N. J.*	73 w.
George Lewis Sargent,	*New Haven,*	51 Elm st.
Louis Jacob Schiller,	*New Haven,*	8 Martin st.
Bernard Joseph Shanley,	*New Haven,*	211 Franklin st.
Frank Augustus Smith,	*New Haven,*	36 Lyon st.
Henry Taber,	*New York City,*	A.
John Heyward Trumbull,	*Talcahuano, Chili,*	41 Trumbull st.
Richard Lindsay Trumbull,	*Talcahuano, Chili,*	41 Trumbull st.
Howard VanRensselaer,	*Albany, N. Y.*	23 Prospect st.
Frank Charles Warner,	*West Suffield,*	116 College st.
Robert William Watson,	*Ashtabula, O.*	489 Chapel st.
William Meeker Wood,	*Morristown, N. J.*	489 Chapel st.
Arthur Burnham Woodford,	*West Winsted,*	116 College st.
Clark Wright,	*West Roxbury, Mass.*	82 Wall st.
Willis Benton Wright,	*Cromwell,*	88 Grove st.

SENIORS, 45.

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JUNIOR CLASS.

Horace Ellsworth Andrews,	*Cleveland, O.*	43 College st.
George Jackson Angell,	*Brooklyn, N. Y.*	43 College st.
Alfred Warren Armstrong,	*Cleveland, O.*	43 College st.
Charles Noyes Batcheller,	*Wallingford, Vt.*	6½ York sq.
Henry Jonathan Biddle,	*Philadelphia, Pa.*	36 Elm st.
Francis Hayes Blake,	*New Haven,*	Mill Rock.
Nathan Gross Bozeman,	*New York City,*	196 Crown st.
Frederick Casper,	*West Meriden,*	529 Chapel st.
Charles Chamberlain,	*Brooklyn, N. Y.*	489 Chapel st.
William Anson Chamberlin,	*New Haven,*	30 Trumbull st.
Kū Yung Chun.	*Canton, China,*	44 Elm st.
William Henry Crocker,	*San Francisco, Cal.*	36 Elm st.
Walter Root Downs,	*New Haven,*	64 LaFayette st.
James John Drummond,	*Winfield, Ill.*	6½ York sq.
Robert Ogden DuBois,	*New Haven,*	328 Howard av.
George Mortimer Dunham,	*Unionville,*	109 Elm st.
Richard Lawrence Everit,	*New Haven,*	281 Whitney av.
Herbert Waldron Faulkner,	*Stamford,*	233 York st.
William Alanson Hall,	*Morris,*	95 Wooster st.
Alexander Bryan Johnson,	*Utica, N. Y.*	83 w.
Herbert Deatherage Lacey,	*Brooklyn, N. Y.*	36 Elm st.
Frederick William La Forge,	*Waterbury,*	6½ York sq.
Frank Judson Lambert,	*New Haven,*	12 Eld st.
Norman Smith Latham,	*North Manchester,*	120 Dwight st.
Cassius Samuel Lyman,	*Holyoke, Mass.*	25 Prospect st.
Nathaniel White Lynde,	*West Brookfield, Mass.*	6½ York sq.
William Danforth MacQuesten,	*Washington, D. C.*	167 Temple st.
Sheldon Elton Minor,	*Thomaston,*	167 Temple st.
Nagamoto Okabe,	*Tokio, Japan,*	92 Grove st.
Edward E. Paramore,	*St. Louis, Mo.*	36 Elm st.
Lewis Valentine Pirsson,	*New York City,*	121 Park st.
Harry Smith Pope,	*Jersey City, N. J.*	61 w.
James Edward Pope, Jr.,	*Jersey City, N. J.*	61 w.
John Hutchinson Robinson,	*Lake Village, Ark.*	215 York st.
Robert Browning Rood,	*Great Barrington, Mass.*	167 Temple st.
Charles Edward Stockder, Jr.,	*West Meriden,*	6½ York sq.
Fred Moore Strong,	*Chicago, Ill.*	36 Elm st.
Arthur Graham Thompson,	*Milford,*	43 College st.
Edwin Thorne,	*New York City,*	65 Whitney av.
Thomas Pearsall Thorne,	*Millbrook, N. Y.*	65 Whitney av.
Walter Joy Vought,	*Buffalo, N. Y.*	85 w.
Edward Loder Whittemore,	*Rye, N. Y.*	76 w.
Alfred Buckingham Willcox,	*Chicago, Ill.*	76 w.
Chauncey Pratt Williams, Jr.,	*Albany, N. Y.*	36 Elm st.
S. Lawrence Williams,	*Chicago, Ill.*	36 Elm st.
Chan Lok Wing,	*China,*	44 Elm st.

JUNIORS, 46.

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FRESHMAN CLASS.

Paul Whitin Abbott,	*New Haven*,	257 Church st.
Gustavo Alfonso,	*New York City*,	88 Wall st.
John Alpheus Allen,	*New Haven*,	189 Temple st.
Theodore Davenport Bacon,	*Norwich*,	247 Church st.
Benjamin Safford Barrows,	*Hartford*,	128 High st.
George Andrew Barrows,	*Philadelphia, Pa.*	114 College st.
Henry Dudley Barry,	*Constantine, Mich.*	29 Prospect st.
John Bartholomew,	*Guilford*,	15 Wooster pl.
Frederic Robinson Bartlett,	*Freeport, Ill.*	192 York st.
Frederick Elijah Beach,	*New Haven*,	33 Lyon st.
Henry Whitney Berryman,	*New York City*,	117 York st.
William Williams Bond,	*New London*,	33 Prospect st.
Isaac Judson Boothe,	*Birmingham*,	84 Wall st.
Charles Allan Bowles,	*Springfield, Mass.*	94 Grove st.
Frederick Truman Bradley,	*New Haven*,	142 Orange st.
Charles Parker Breese,	*Meriden*,	529 Chapel st.
Charles Sumner Brown,	*East Hampton*,	12 Trumbull st.
Charles Milo Carpenter,	*Madison, Wisc.*	167 Temple st.
Horace Raymond Carpenter,	*Afton, N. Y.*	162 York st.
Fred Willis Chapman,	*Chico, Cal.*	82 Wall st.
Samuel Myron Chase,	*Chicago, Ill.*	184 York st.
Harry Nelson Covell,	*Stamford*,	200 York st.
Wayne Darlington,	*West Chester, Pa.*	120 High st.
Edward Bradford Dench,	*Bridgeport*,	18 E.
Henry Kelsey Devereux,	*Cleveland, O.*	55 Trumbull st.
Edward Peers Eastwick, Jr.	*New York City*,	192 York st.
Frank Hynard Edsall,	*Hamburgh*,	128 High st.
Horatio Southworth Frazer,	*Holyoke, Mass.*	134 College st.
Harry Brainard Gaylord,	*New Haven*,	40 Academy st.
Charles Lockwood Gold,	*West Cornwall*,	49 Grove st.
Charles Stewart Hall,	*Warren, O.*	49 Grove st.
George Vance Harper,	*Sing Sing, N. Y.*	82 Wall st.
William Harper,	*Shippensburg, Pa.*	82 Wall st.
William Howard Hart,	*New Haven*,	82 Trumbull st.
Allen Hubbard,	*Westfield, Mass.*	6½ York sq.
Arthur Henry Jackson,	*New Haven*,	12 Warren st.
Henry Clay Johnson,	*Rome, Ga.*	153 Crown st.
Wylie Brantley Jones,	*New Haven*,	89 Wooster st.
Tsu Ye Ki,	*Shanghai, China*,	144 High st.
William Klein,	*New Haven*,	86 Nicoll st.
John Elmer Lockwood,	*Stamford*,	146 Dixwell av.
William Ellison Lockwood,	*Stamford*,	146 Dixwell av.
James Lyman,	*Middlefield*,	107 W.
John Lyman,	*Middlefield*,	107 W.
George Smith Hunt McDowell,	*Portland, Me.*	33 Prospect st.

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John Henry Mann,	*Utica, N. Y.*	116 w.
Donald Grant Mitchell, Jr.	*Edgewood,*	84 Wall st.
Oliver Rockwell Morgan,	*Glastonbury,*	187 Temple st.
John Edmund Newell,	*Chicago, Ill.*	464 Chapel st.
Henry Curtis Nutt,	*Chicago, Ill.*	489 Chapel st.
Frank Spooner Parrott,	*Bridgeport,*	36 Elm st.
George Shipman Payson,	*Chicago, Ill.*	464 Chapel st.
Edward Wells Penfield,	*Chicago, Ill.*	94 Grove st.
David Murdoch Pratt,	*Elmira, N. Y.*	198 Crown st.
Willie Sherman Randall,	*Birmingham,*	72 High st.
Robert Ranlet,	*Holyoke, Mass.*	134 College st.
Albert William Robert,	*New York City,*	237 Orange st.
Joseph Warren Rogers, Jr.	*Scarborough, N. Y.*	82 Wall st.
Alfred Hughes Rowe,	*Fair Haven,*	Fair Haven.
Frederick Baylies Samson,	*Richmond, Ind.*	165 Temple st.
Charles Lansing Sayre,	*Utica, N. Y.*	116 w.
Horace Lee Simpson,	*Pensacola, Fla.*	198 Crown st.
Ebenezer Hubbard Skinner,	*Escambia, Fla.*	198 Crown st.
Joseph Allen Skinner,	*Holyoke, Mass.*	146 College st.
Edward Irving Stone,	*Bethlehem,*	365 Orchard st.
John Edwards Stryker,	*Catskill, N. Y.*	29 Prospect st.
Elmer Ellsworth Thompson,	*St. Louis, Mo.*	55 Trumbull st.
Charles Ridgway VanBlarcom,	*Cornwall, N. Y.*	88 Wall st.
Alonzo Felton Wood, Jr.	*West Haven,*	77 George st.
Alexander Wurts,	*New Haven,*	65 Whitney av.
Robert Hawthorne Wylie,	*Chester, S. C.*	258 Orange st.

FRESHMEN, 71.

SPECIAL STUDENTS NOT CANDIDATES FOR A DEGREE.

Louis Asta Buruaga,	*Santiago, Chili,*	258 Orange st.
John Lindley Coates,	*Kansas City, Mo.*	66 w.
Glover Edward Sanford,	*Bridgeport,*	494 Chapel st.
Joseph Singler,	*Ansonia,*	Ansonia.
Hiram Colin Slavens,	*Kansas City, Mo.*	66 w.
Warren A. Spalding,	*New Haven,*	89 Church st.
William Bradbury Spring,	*Portland, Me.*	36 Elm st.
William Fletcher Stone,	*New Haven,*	143 Lamberton st.
William Petit Trowbridge, Jr.	*New Haven,*	82 Prospect st.

SPECIAL STUDENTS, 9.

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SUMMARY.

Graduates,	20
Seniors,	45
Juniors,	46
Freshmen,	71
Special,	9
Total,	191

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SHEFFIELD SCIENTIFIC SCHOOL.

I.

OBJECTS.

The Sheffield Scientific School is devoted to instruction and researches in the mathematical, physical, and natural sciences, with reference to the promotion and diffusion of science, and also to the preparation of young men for such pursuits as require especial proficiency in these departments of learning. It is one of the Departments of Yale College, like the law, medical, theological, and art schools, having its separate funds, buildings, teachers, and regulations, but governed by the Corporation of Yale College, which appoints the professors and confers the degrees. It is, in part, analogous to the academic department, or classical college, and, in part, to the professional schools.

The instruction is intended for two classes of students:—

I. Graduates of this or of other Colleges, and other persons qualified for advanced or special scientific study.

II. Undergraduates who desire a training chiefly mathematical and scientific, in less part linguistic and literary, for higher scientific studies, or for various other occupations to which such training is suited.

II.

HISTORY AND ORGANIZATION.

The School was commenced in 1847. In 1860, a convenient building and a considerable endowment were given by Joseph E. Sheffield, Esq., of New Haven, whose name at the repeated request of the Corporation of Yale College, was afterward attached to the foundation. Mr. Sheffield has since frequently and munificently increased his original gifts.

In 1863, by an act of the Connecticut Legislature, the national grant for the promotion of scientific education (under the congressional enactment of July, 1862) was given to this department of Yale College. Since that time, and especially since the autumn of 1869, numerous liberal gifts have been received from the citi-

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zens of New Haven, and from other gentlemen in Connecticut, New York, and St. Louis, for the endowment of the School, and the increase of its collections.

The action of the State led to the designation by law of a State Board of Visitors, consisting of the Governor, Lieutenant-Governor, three senior Senators, and the Secretary of the State Board of Education; and this Board, with the Secretary of the Scientific School, is also the Board for the appointment of students to hold the State scholarships.

At the request of the Governing Board, the Corporation of Yale College has also appointed a Board of Councillors for the School, consisting of a number of gentlemen who have taken a deep interest in its welfare.

The Governing Board consists of the President of Yale College and the Professors who are permanently attached to the School. There are several other instructors associated with them, a part of whom are connected with other departments of the College.

III.

BUILDINGS AND APPARATUS.

The two buildings in which the work of instruction in the Scientific School is mainly carried on are called Sheffield Hall and North Sheffield Hall; but instruction in Mineralogy, Geology, and Biology, including Zoölogy and Comparative Anatomy, is now given entirely in the Peabody Museum. These halls contain a large number of recitation and lecture rooms, a hall for public assemblies and lectures, chemical and metallurgical laboratories, a photographical room, an astronomical observatory, museums, a library and reading room, besides studies for some of the professors, where their private technical libraries are kept.

The following is a summary statement of the collections belonging to the School:

1. Laboratories and Apparatus in Chemistry, Metallurgy, Physics, Photography, and Zoölogy.
2. Metallurgical Museum of Ores, Furnace Products, etc.
3. Agricultural Museum of Soils, Fertilizers, useful and injurious insects, etc.
4. Collections in Zoölogy.
5. Astronomical Observatory, with an equatorial telescope by Clark and Sons of Cambridge, a meridian circle. etc.
6. A Collection of Mechanical Apparatus, constituting the "Collier Cabinet."

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7. Models in Architecture, Geometrical Drawing, Civil Engineering, Topographical Engineering, and Mechanics; diagrams adapted to public lectures; instruments for field practice.
8. Maps and Charts, topographical, hydrographical, geological, etc.

The herbarium of Professor Brewer, and the astronomical instruments of Professor Lyman, are deposited in the buildings. Professor Eaton's herbarium, near at hand, is freely accessible. Students also have access to the various laboratories and collections in Natural Science in the Peabody Museum.

Students are also admitted, under varying conditions, to the College and Society libraries, the College Reading Room, the School of the Fine Arts, and the Gymnasium.

IV.

THE LIBRARY.

The special technical library of the Scientific School consists of about five thousand volumes. Included in this is the "Hillhouse Mathematical Library" of twenty-four hundred volumes, collected during a long series of years by Dr. William Hillhouse, and in 1870 purchased and presented to the Institution by Mr. Sheffield. A catalogue of this collection forms a supplement to the Annual Report of the Governing Board for 1870. All the prominent scientific journals of this country and of Europe, together with the proceedings of foreign academies, and of scientific societies, can be found either in this library or in the College Library to which students have access.

V.

INSTRUCTION FOR GRADUATE AND SPECIAL STUDENTS.

Persons who have gone through undergraduate courses of study, here or elsewhere, may avail themselves of the facilities of the School for more special professional training in the physical sciences and their applications, gaining in one, two, or three years the degree of Bachelor of Philosophy, or, in two additional years of Engineering study, that of Civil Engineer, or of Dynamic Engineer.

Or, engaging in studies of a less exclusively technical character, they may become candidates for the degree of Doctor of Philosophy. The instruction in such cases will be adapted to the particular needs and capacities of each student, and may be combined with that given by the graduate instructors in other departments of the University. This degree is conferred upon those who, hav-

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ing already taken a Bachelor's degree, engage as students in the Department of Philosophy and the Arts for not less than two years in assiduous and successful study. It is not given upon examination to those whose studies are pursued elsewhere. The requirements for it will in some cases exact of the student more than two years of post-graduate labor; so, especially, wherever the course of undergraduate study has been, as in the Scientific School, of less than four years. The candidate must pass a satisfactory final examination, and present a thesis giving evidence of high attainment in the branches of knowledge to which he has attended. A good knowledge of Latin, German and French will be required in all cases, unless, for some exceptional reason, the candidate be excused by the Faculty. The graduating fee is ten dollars.

Subjects likely to receive special attention are suggested as follows:

Professor NORTON will instruct in applied mechanics and in spherical astronomy.

Professor LYMAN, in the use of meridional and other astronomical instruments, and in astronomical spectroscopy.

Professor DUBOIS, in the principles of thermodynamics, and utilization of heat as a source of power.

Professor BRUSH, in the analysis and determination of mineral species, and in descriptive mineralogy.

Professor JOHNSON, in theoretical, analytical, and agricultural chemistry.

Professor BREWER, in agriculture and forest culture, in the use of the microscope, and in physical geography.

Professor CLARK, in definite integrals, differential equations, analytical mechanics, the theory of numerical approximations, and the method of least squares.

Professor EATON, in structural and systematic botany, including the North American flora and the description of genera and species.

Professor WALKER, in public finance and in the statistics of industry.

Professor ALLEN, in analytical chemistry, and in metallurgy.

Professor VERRILL, and Professor SMITH, in zoology and geology.

The same courses of study are open, for a longer or shorter time, to graduate students who do not desire to become candidates for a degree.

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Students who have taken the degree of Bachelor of Philosophy, may obtain the degree of CIVIL or of DYNAMIC ENGINEER at the end of two academical years, by pursuing the following higher course of study and professional training.

The course of study for the degree of CIVIL ENGINEER will comprise—

1. Higher Calculus. Higher Geometry. Theory of Numerical Operations.
2. Analytical Mechanics. Mechanics applied to Engineering.
3. A Course of Construction and Design. Projects.
4. Practical Astronomy, with use of instruments, computations, etc.

This course will occupy one year.

To secure the requisite amount of professional knowledge and practice, the candidate will be required to furnish a comprehensive report of the results of an examination into the existing condition of some special line of constructive art; or to present proper evidence that he has had actual charge in the field, for several months, of construction or surveying parties, or held some responsible position deemed equivalent to this.

An elaborate design must also be submitted of some projected work of construction, based upon exact data obtained from careful surveys made by the candidate, and comprising all the requisite calculations, and the necessary detailed drawings, and accompanied by full specifications of the work to be done, and the requirements to be met by the contractor.

The fee for this degree is five dollars.

The course of study for the degree of DYNAMIC ENGINEER will comprise—

1. Higher Calculus. Higher Geometry. Theory of Numerical Operations.
2. General Principles of Dynamics (Analytical Mechanics), including special application of these principles to Dynamical problems.
3. Construction of Machines. Designs.
4. Preparation of theses on special subjects in Dynamic Engineering.

During the second year candidates will be permitted to employ such a portion of their time as may be deemed advisable or necessary in the examination of engineering works and manufacturing establishments, and may also have the privilege of entering upon professional practice, provided it is done with the knowledge and consent of the Professor of Dynamic Engineering, and under such circumstances as shall appear to him to be favorable to professional progress.

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An elaborate thesis on some professional subject, with an original design, or project, accompanied by proper working drawings, will be required at the end of the second year.

The fee for this degree is five dollars.

SPECIAL STUDENTS.—For the benefit of those who, being fully qualified, desire to pursue particular studies without reference to the obtaining of a degree, special or irregular students are received in most of the departments of the School; not, however, in the Select Course or in the Freshman Class.

It should be distinctly understood that these opportunities are not offered to persons who are incompetent to go on with regular courses, but are designed to aid those who, having received a sufficient preliminary education elsewhere, desire to increase their proficiency in special branches.

VI.

REQUIREMENTS FOR ADMISSION AND COURSES OF INSTRUCTION FOR UNDERGRADUATE STUDENTS.

TERMS OF ADMISSION.—Candidates must be not less than fifteen years of age, and must bring satisfactory testimonials of moral character from their former instructors or other responsible persons.

For admission to the Freshman Class the student must pass a thorough examination in the following subjects:

English—including grammar, spelling and composition. In grammar, Whitney's Essentials of English Grammar, or an equivalent.

History of the United States.

Geography.

Latin—six books of Cæsar's Commentaries, or their equivalent, and simple exercises in prose composition.

Arithmetic—including the metric system of weights and measures.

Algebra—so much as is contained in Loomis's Treatise, up to the general theory of equations.

Geometry—Plane, solid and spherical; including fundamental notions of symmetry, and examples of loci and of maxima and minima of plane figures:—an equivalent of the nine books of Chauvenet's Treatise, or of the ten books of Loomis's Elements and the Appendix, up to the section on Transversals.

Trigonometry—including the analytical theory of the trigonometrical functions, and the usual formulæ; the construction and use of trigonometrical tables; and the solution of plane triangles;—so much, for example, as is contained in Wheeler's Plane Trigonometry (Boston, 1877), or Richards's Plane Trigonometry (New York, 1878).

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While no entrance examination is held in the *History of England*, candidates for admission are urgently advised to make themselves as familiar as possible with that subject; as a knowledge of it is essential to the most successful prosecution of some of the studies of the course.

Candidates will be allowed the option of passing on the above-named subjects in two successive years. In such a case they must present themselves for examination at the June examination of the first year in the following subjects or parts of subjects: *History of the United States*, *Geography*, *Arithmetic*, *Plane Geometry*, and *Algebra to Quadratic Equations*.

In order to have this preliminary examination counted, candidates must pass satisfactorily on *all* the subjects; and notice must be given of the intention to divide the examination to Professor G. J. Brush, Executive Officer of the School, on or before June 15th.

In his preparation in GEOMETRY the candidate should, as far as practicable, have suitable exercises in proving simple theorems and solving simple problems for himself. It is important, too, that he should be accustomed to the numerical application of geometric principles, and especially to the prompt recollection and use of the elementary formulæ of mensuration. In TRIGONOMETRY he should be exercised in applying the usual formulæ to a variety of simple reductions and transformations, including the solution of trigonometrical equations. Readiness and accuracy in trigonometrical calculations are also of prime importance to the candidate. If the use of logarithms is postponed in his preparation till Trigonometry is taken up (which is by no means necessary or advisable), he should then have abundant application of them to all forms of calculation occurring in ordinary practice, as well as to those appearing in the solution of triangles. Finally, in all of his calculations, he should study the art of neat, orderly, and readily intelligible arrangement.

In LATIN, in order to secure the attainment of the required proficiency, the student should have such continued training in parsing as shall make him thoroughly familiar with declensions and conjugations, and accurate and ready in the application of the rules of syntax. As an additional guarantee of the proper mastery of these grammatical elements, the requirement has been adopted of "simple exercises in prose composition." By this is meant merely, such a course of elementary exercises in translation, orally and in writing, from English into Latin as, in connection with the systematic parsing just mentioned, shall necessitate a familiarity with grammatical forms and the leading principles of syntax, and thus render the reading of the six books of Cæsar (or their equivalent) more thorough and fruitful. Since this course of elementary exercises in translation is designed as a preparation for reading, and not as a sequel to it, it should be invariably begun at the earliest stage of the study of Latin. To avoid any misapprehension of the nature of the extent of the requirement, the following works are specifically, named, among which the candidate for examination may make his own selection,

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These are Harkness's "Introduction to Latin Composition," 112 pages; Leighton's "Latin Lessons," 91 pages; Smith's "Principia Latina," Part I.; McClintock's "First Latin Book," 83 lessons (193 pp.). Any equivalent of these may be offered from the many useful books of a similar character. A knowledge of Prosody is not required.

The examinations for admission take place at North Sheffield Hall, on Thursday, Friday, and Saturday, June 30, July 1, 2, and on Tuesday and Wednesday, September 13, 14, 1881. Opportunity for private examinations may, in exceptional cases, be given at other times.

In 1881 examinations (for the Freshman Class only) will also be held in Chicago and in Cincinnati (beginning on Thursday, June 30, at 9 A. M.), at a place to be announced in the local newspapers of the day previous. Candidates who propose to be present are requested to send their names to Professor G. J. Brush, Executive Officer of the School, before June 15. A fee of five dollars will be charged for admission to these examinations.

Candidates for advanced standing in the undergraduate classes are examined, in addition to the preparatory studies, in those already pursued by the class they wish to enter. No one can be admitted as a candidate for a degree, later than at the beginning of the Senior year.

THE COURSES OF INSTRUCTION, occupying three years, are arranged to suit the requirements of various classes of students. The first year's work is the same for all; for the last two years the instruction is chiefly arranged in special courses. The special courses most distinctly marked out are the following:—

(*a.*) In Chemistry;
(*b.*) In Civil Engineering;
(*c.*) In Dynamical (or Mechanical) Engineering;
(*d.*) In Agriculture;
(*e.*) In Natural History;
(*f.*) In Biology preparatory to Medical Studies;
(*g.*) In studies preparatory to Mining and Metallurgy;
(*h.*) In Select studies preparatory to other higher studies.

The arrangement of the studies is indicated in the annexed scheme.

FRESHMAN YEAR—INTRODUCTORY TO ALL THE COURSES.

FIRST TERM—*German*—Whitney's Grammar and Reader. *English*—Lounsbury's History of the English Language; Exercises in Composition. *Mathematics*—Analytical Geometry. *Physics*—Atkinson's Ganot, with experimental lectures. *Chemistry*—Recitations and Laboratory Practice. *Elementary Drawing*—Practical Lessons in the Art School.

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SECOND TERM—*Language, Physics, and Chemistry*—as stated above. *Mathematics*—Spherical Trigonometry (Wheeler's); Elements of Mechanics. *Physical Geography*—Lectures. *Botany*—Gray's Lessons, with Lectures. *Political Economy*—Elementary Lectures. *Drawing*—Isometric Drawing, with application to drawing from models and structures by measurement. Shading and tinting. Principles of orthographic projection. Reading of working drawings and isometric construction of objects from their orthographic projections. Sections.

For the Junior and Senior years the students select for themselves one of the following courses:

(a.) IN CHEMISTRY.

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. *Qualitative Analysis* — Fresenius's. *Laboratory Practice. Blowpipe Analysis. German. French.*

SECOND TERM—*Laboratory Practice*—Quantitative Analysis. *Mineralogy*—Blowpipe Analysis and Determination of Species. Lectures. *French. German.*

SENIOR YEAR:

FIRST TERM—*Organic Chemistry*—Lectures and Recitations. *Agricultural Chemistry*—Recitations (optional). *Laboratory Practice*—Volumetric and Organic Analysis. *Geology*—Dana's. *Zoology*—Lectures. *French.*

SECOND TERM—*Laboratory Practice*—Mineral Analysis and Assaying. *Geology*—Dana's Manual. *Metallurgy* (optional). *Mineralogy* (optional). *French.*

(b.) IN CIVIL ENGINEERING.

JUNIOR YEAR:

FIRST TERM—*Mathematics*—Elements of the Theory of Functions; Numerical Equations; Differential Calculus. *Surveying*—Field Operations. *Drawing*—Descriptive Geometry, begun. *German. French.*

SECOND TERM—*Mathematics*—Integral Calculus. Rational Mechanics. *Drawing*—Descriptive Geometry, concluded. Topographical. *Surveying*—Topographical. *German. French.*

SENIOR YEAR:

FIRST TERM—*Field Engineering*—Laying out Curves. Location of line of Railroad, with calculations of Excavation and Embankment. Hencks's Field Book for Railroad Engineers. *Civil Engineering*—Resistance of Materials. Bridges and Roofs, begun. Stone Cutting, with Graphical problems. *Geology*—Dana's. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *French.*

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SECOND TERM—*Civil Engineering*—Bridges and Roofs. Building Materials. Stability of Arches and Walls. Mahan's Civil Engineering. *Dynamics*—Principles of Mechanism. Steam Engine. *Hydraulics*—Hydraulics and Hydraulic Motors. *Drawing*—Graphical Statics. *Astronomy*—Loomis's Astronomy, with practical problems. *Mineralogy*—continued. *Geology*—Dynamic. *French.*

(c.) IN DYNAMIC ENGINEERING.

JUNIOR YEAR:

FIRST TERM—*Mathematics*—Elements of the Theory of Functions; Numerical Equations; Differential Calculus. *Surveying*—Field Practice. *Drawing*—Descriptive Geometry, begun. *German. French.*

SECOND TERM—*Mathematics*—Integral Calculus. Rational Mechanics. *Kinematics*—General Theory of Motion and Principles of Mechanism; Elementary Combinations of pure Mechanism; Pulleys and Belts; Gearing and forms of teeth for wheels; Parallel Motions. *Drawing*—Descriptive Geometry, concluded. *German. French.*

SENIOR YEAR:

FIRST TERM—*Statics*—Application of the Principles of Statics to Rigid Bodies; Elasticity and Strength of Materials; Forms of Uniform Strength; Stability of Structures; Construction of Roof Trusses, Girders, and Iron Bridges. *Machine Drawing*—Bolts and Nuts; Riveting; Journals, Axles, Shafts, Couplings, Pillow Blocks; Shaft-hangers, Pulleys; Connecting Rods and Cranks; Cross-heads; Pipe Connections; Valves; Steam Cylinders, Stuffing Boxes, Glands, etc. Shop Visits. *Blowpipe Analysis. French.*

SECOND TERM—*Hydrostatics and Hydrodynamics*—Equilibrium and Pressure of fluids; Hydrometers, Manometers, Gauges, etc.; Water Pressure Engines and Water Wheels; Construction of Water Reservoirs and Conduits; Measurements of Water Supply; Discharge of Pipes. *Thermodynamics*—General principle of Heat employed as a source of power; Theory of the Steam Engine; Hot Air Engines; Gas Engines. *Machine Designing*—Proportioning of Machine Parts, continued. Designing of Hoisting Engines; Shearing and Pumping Engines; complete working drawings for a high speed Steam Engine. Shop Visits and Reports. *Metallurgy.*

(d.) IN AGRICULTURE.

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. *Qualitative Analysis* — Fresenius's. *Laboratory Practice. Blowpipe Analysis. German. French.*

SECOND TERM — *Laboratory Practice*—Quantitative Analysis. *Mineralogy*—Blowpipe Analysis and Determination of Species. *Physical Geography*—Lectures. *Physiology*—Huxley's. *Botany*—Lectures. *French. German.*

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SENIOR YEAR:

FIRST TERM—*Agriculture*—Cultivation of the Staple Crops of the Northern States. Tree Planting and Forestry. *Agricultural Chemistry*—Johnson's. *Organic Chemistry*—Lectures and Recitations. *Geology*—Dana's. *Zoology*. *English*. *French*.

SECOND TERM—*Agriculture*—Laws of Heredity and Principles of Breeding; Lectures. *Geology*—Dana's. *Rural Economy*—History of Agriculture and Sketches of Husbandry in Foreign Countries; Systems of Husbandry. *Agricultural Chemistry*—Johnson's. *Geology*—Dana's. *Zoology*. *Botany*. *Microscopy*. *English*. *French*.

(e.) IN NATURAL HISTORY.

(Either Geology, Mineralogy, Zoology, or Botany, may be made the principal study, some attention in each case being directed to the other three branches of Natural History.)

JUNIOR YEAR:

FIRST TERM—*Chemistry*—Qualitative Analysis; Laboratory Practice; Recitations. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *Botany*—Gray's Manual; Laboratory Practice. *German*. *French*.

SECOND TERM—*Zoology*—Laboratory Practice; Recitations; Excursions (land and marine). *Botany*—Laboratory Practice; Excursions. *Physiology*—Huxley's. *Mineralogy*—continued. *Physical Geography*. *German*. *French*.

SENIOR YEAR:

FIRST TERM—*Geology*—Dana's; Excursions. *Zoology*—Laboratory Practice; Lectures; Recitations; Excursions. *Botany*—Herbarium Studies; Gray's Textbook; Excursions. *French*.

SECOND TERM—*Geology*—Dana's. *Anatomy of Vertebrates*—Huxley's. *Zoology*—Laboratory Practice; Recitations; Lectures. *Botany*—Herbarium Studies, especially in the Cryptogamous Orders; Botanical Literature; Essays in Descriptive Botany. *Meteorology*. *French*.

Besides the regular courses of recitations and lectures on structural and systematic Zoology and Botany, and on special subjects, students are taught to prepare, arrange, and identify collections, to make dissections, to pursue original investigations, and to describe genera and species in the language of science. For these purposes, large collections in Zoology and Palæontology belonging to the College are available, as are also the private botanical collections of Professor Eaton.

(f.) IN BIOLOGY—PREPARATORY TO MEDICAL STUDIES.

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. *Qualitative Analysis*—Fresenius's; Laboratory Practice; Recitations. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *German*. *French*.

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SECOND TERM—*Physiology*—Huxley's, with Practical Exercises. *Toxicology*—Fresenius's; Laboratory Practice; Recitations and Lectures. *Physiological Chemistry*—Sanderson's Handbook; Recitations and Laboratory Work. *Mineralogy* — continued. *Botany* — Lectures, Practical Exercises in Phenogamous Plants, and Excursions. *German. French.*

SENIOR YEAR:

FIRST TERM—*Physiological Chemistry*—continued. *Organic Chemistry*—Lectures and Recitations. *Zoology*—Lectures. *Botany*—Practical Exercises. Lectures and Excursions. *Geology*—Dana's Manual. *French.*

SECOND TERM—*Comparative Anatomy and Histology*—Laboratory Practice and Recitations. *Geology*—Dana's Manual. *Zoology*—Lectures. *Laws of Heredity and Breeding*—Lectures. *French.*

(g.) IN STUDIES PREPARATORY TO MINING AND METALLURGY.

Young men desiring to become Mining Engineers, can pursue the regular course in Civil and Mechanical Engineering, and at its close can spend a fourth year in the study of metallurgical chemistry, mineralogy, etc.

(h.) IN THE SELECT STUDIES PREPARATORY TO OTHER HIGHER STUDIES.

JUNIOR YEAR:

FIRST TERM—*Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *Astronomy. English*—Early English. *History*—Freeman's Outlines. *French. German.*

SECOND TERM—*Mineralogy*—Lectures. *Physical Geography*—Guyot; Lectures. *Botany*—Lectures: Excursions; Laboratory Practice. *English*—Chaucer, Bacon, Shakspere. *History*—Freeman's Outlines, with Lectures. *Political Economy*—Rogers's Manual. *German. French.*

SENIOR YEAR:

FIRST TERM—*Geology*—Recitations and Excursions. *Zoology*—Lectures and Excursions. *Linguistics*—Whitney's Life and Growth of Language. *English*—Shakspere. *History*—Constitutional History of the United States; Lectures. *Political Economy*—Lectures. *French.*

SECOND TERM—*Geology*—continued. *Meteorology*—Lectures. *Political Economy*—Lectures. *English* — Shakspere, Milton, Dryden, Pope, and later authors. *History*—Political History of U. S.; History of Europe from 1848; Lectures. *French.*

Exercises in English Composition are required during the entire course from all the students. The preparation of graduation theses is among the duties of the Senior Year.

Lectures on Military Science and Tactics are annually given by General Abbott, and other officers of the Engineer Corps of the United States Army.

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DRAWING.—The course in drawing extends through the three years. During the first term of Freshman year, the students practice free-hand drawing at the Art School building, under the direction of Professor Niemeyer, of the Yale School of the Fine Arts. After the completion of the course in free-hand drawing, instruction is given by Mr. F. R. Honey, during the second term in the elementary principles of instrumental drawing, embracing Elementary projection drawing, Isometric drawing, and Descriptive Geometry as far as Warped Surfaces. This course is obligatory upon all.

During the Junior and Senior years, instruction in drawing is obligatory only on the students in Civil and Mechanical Engineering. In the former year the system of instruction embraces shades and shadows, tinting, perspective, and warped surfaces. By this method all the problems in Descriptive Geometry are required to be worked out on the drawing-board instead of the black-board. The course extends through the entire year, and is under the direction of Mr. Honey.

In Senior year, students are required to apply the principles of drawing already obtained to works of construction, under the general supervision of the Professors of Civil and of Dynamic Engineering.

VII.

METHODS OF INSTRUCTION.

The instruction of this institution is given chiefly in small class rooms, in connection with recitations and by familiar lectures, illustrated by the apparatus at the command of the various teachers. In many studies weekly excursions are made for the purpose of collecting specimens and examining natural phenomena.

In Chemistry and Metallurgy the students work several hours daily in well-appointed laboratories, under the direct superintendence of the instructors, and are guided through systematic courses of quantitative and qualitative analysis, assaying, and the blow-pipe determination of minerals and ores.

In Botany, during the summer of Junior year, exercises in analyzing and identifying plants occur two or three times a week, followed by practice in writing characters and descriptions of plants from living specimens. Students are shown also the best methods of collecting and preserving for future study, specimens of Flowering Plants, Ferns, Mosses, Algæ, etc. In the autumn

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term of Senior year the work of the summer is continued. Students are encouraged to pursue special lines of Botanical investigation, and varied assistance is rendered them according to their needs. The final examination is intended to show what they have learned, and the collections they have made are considered to be of minor importance.

In Zoology excursions are made during the third term of Junior and first term of Senior year, in company with the instructors, for the purpose of observing the habits and making collections of marine, fresh-water, and terrestrial animals of all classes. Each student is required to prepare and present for examination a collection containing a specified number of species, and illustrating the various classes of animals. He must also be able to pass an examination upon his collection, at least to the extent of explaining the classes and orders illustrated, and showing why particular specimens belong to the respective classes.

In Geology excursions are made for the purpose of examining geological phenomena and making special collections of rocks and minerals. Each student is required to pass a satisfactory examination on his collections at the end of the first term of Senior year.

In addition to the above, a course of lectures is given every winter by the professors of the schools and others, on topics of popular interest.

VIII.

TUITION CHARGES.

The charge for tuition for undergraduate students is $150 per year, payable, $55 at the beginning of the first and of the second term, and $40 at the middle of the second term. The special student of Chemistry has an additional charge of $70 per annum for chemicals and use of apparatus. He also supplies himself at his own expense with gas, flasks, crucibles, etc., the cost of which should not exceed $10 per term. A fee of $5 is charged members of the Freshman Class for chemicals and materials used in their laboratory practice, and the same fee is required from all (except Chemical students) who take the practical exercises in Blow-pipe Analysis and Determinative Mineralogy. A fee of $5 a term will also be charged to the students in the Zoological laboratory, for materials and use of instruments. An additional charge of $5 is annually made to each student for the use of the College Reading Room and Gymnasium.

For graduate students the charge for tuition is $100 per year.

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IX.

CHURCH SITTINGS.

Free sittings for students in this department of Yale College are provided as follows: in the Center Church (Cong.); in the Trinity (Epis.); and in the First Methodist Church.

Those who prefer to pay for a sitting for a year, more or less, in the churches above mentioned, or in any other church of any denomination, will be aided on application to the Secretary of the School.

Sittings in the Gallery of the College Chapel are free as heretofore to the students of this department.

X.

DEGREES.

Students of this department, on the recommendation of the Governing Board, are admitted by the Corporation of Yale College to the following degrees. They are thus conferred:

1. Bachelor of Philosophy: on those who complete any of the three-years courses of study, passing all the examinations in a satisfactory manner, and presenting a graduation thesis.

The fee for graduation as Bachelor of Philosophy including the fee for Triennial Catalogues, Commencement Dinners, etc., is $10; unless the person taking the degree is also an academical graduate, when it is but $5.

2. Civil Engineer and Dynamical Engineer: The requirements for these degrees are stated on pages 17–18.

3. Doctor of Philosophy: The requirements for this degree are stated on page 16.

XI.

TERMS AND VACATIONS.

The next academic year begins Thursday, September 15, 1881. The first term begins eleven weeks from Commencement-day and continues fourteen weeks: the second term begins on the second Thursday in January and continues until Commencement-day, with a Spring recess—usually of eight days—including Easter. (See Calendar, p. 2.)

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XII.

ANNOUNCEMENT IN RESPECT TO STATE STUDENTS.

The scholarships established in this School in consequence of the bestowal upon it of the Congressional grants are designed to aid young men who are in need of pecuniary assistance in fitting themselves for agricultural and mechanical pursuits of life. All applicants must be citizens of Connecticut. In case there are more applicants than vacancies, candidates will be preferred who have lost a parent in the military or naval service of the United States, and next to these such as are most in need of pecuniary assistance; and the appointments will be distributed as far as practicable among the several counties in proportion to their population. The appointing Board for the current year, consisting of the Board of Visitors of the State and the Secretary of the School, will meet on June 28th, 1881, and at or about the same time in the year 1882, due notice of which will be given by publication in every county of the State. All applications should be made previous to that time. Blank forms for application will be sent, when requested, by Professor GEORGE J. BRUSH, Secretary of the Appointing Board.

XIII.

ANNIVERSARY.

The Anniversary of the School is held on Tuesday of the Commencement week in Yale College, when selections from the graduation theses are publicly read. The degrees are publicly conferred by the President and Fellows of Yale College on Commencement Day.

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APPENDIX.

ENTRANCE EXAMINATION PAPERS.

The following are the papers for 1880, upon which applicants for admission were examined at the June and September examinations.

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ARITHMETIC.

JULY, 1880.

1. (*a*) Select the prime numbers between 1 and 50.
   (*b*) Find the prime factors of 6902.

2. Find the value of $\frac{4\frac{1}{7} - 2\frac{1}{4}}{6\frac{1}{2} - 2\frac{1}{7}}$, in its simplest form.

3. Divide 0.10724 by 0.003125.

4. How many stones 10 inches long, 9 inches broad, and 4 inches thick, would it require to build a wall 80 feet long, 20 feet high and $2\frac{1}{4}$ feet thick, without mortar?

5. The population of a certain town has gained 25 per cent. within the last five years. It is now 6575; what was it five years ago?

6. Extract the square root of 3369 to three places of decimals.

7. Give the approximate value of the meter in inches; of the gram in grains; of the kilogram in pounds avoirdupois; of the liter in liquid quarts.

What is the weight of a liter of pure water at its maximum density?

ARITHMETIC.

SEPTEMBER, 1880.

1. Reduce $\frac{8}{9\frac{1}{10}}$ and $\frac{7}{24\frac{1}{70}}$ to their least common denominator; add the results, and express the sum decimally to four places.

2. If 8 horses consume $3\frac{1}{2}$ tons of hay in 30 days, how long will $4\frac{9}{10}$ tons last 10 horses?

3. A buys 9 per cent. stocks at 25 per cent. premium; and B buys 6 per cent. stocks at 25 per cent. discount: supposing dividends to be paid promptly, what rates of interest will they receive on their investments?

4. Calculate the square root of 2.064 to two places of decimals.

5. Calculate the cube root of 3.3 to two places of decimals.

6. How many hectoliters of grain will a bin hold whose interior length, width, and depth, are each 6 ft. 6 in.

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GEOMETRY.

JULY, 1880.

[State what text-book you have studied and to what extent.]

I.—PLANE GEOMETRY.

1. (*a*) Define the symmetry of a figure with respect to an axis and with respect to a point.

(*b*) Prove that if a figure is symmetrical with respect to two axes perpendicular to each other, it is also symmetrical with respect to the intersection of these axes.

2. An angle formed by a tangent and a chord is measured by one-half the intercepted arc.

2. To bisect a given arc or angle.

4. (*a*) If a perpendicular be drawn from the vertex of the right angle to the hypothenuse of a right triangle, the two triangles thus formed are similar to each other and to the whole triangle.

(*b*) What can you say of the perpendicular as compared with the segments of the hypothenuse? Why?

(*c*) What, of either side about the right angle? Why?

5. On a given straight line to construct a polygon similar to a given polygon.

6. The circumferences of two circles are to each other as their radii, and their areas are to each other as the squares of their radii.

II.—SOLID AND SPHERICAL GEOMETRY.

7. If a straight line and a plane are parallel, the intersection of the plane with planes passed through the line are parallel to that line and to each other.

8. Define a prism. Two prisms are equal, if three faces including a triedral angle of the one are respectively equal to three faces similarly placed including a triedral angle of the other.

9. Every section of a sphere made by a plane is a circle.

10. Between what two limits does the sum of the angles of a spherical triangle lie? Write expressions for the surface and volume of the cylinder, cone and sphere.

NOTE.—Candidates who present themselves for the whole examination may omit questions 2, 3 and 5. Candidates who present themselves for the partial examination will confine themselves to the questions in Plane Geometry.

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GEOMETRY.

SEPTEMBER, 1880.

[State what text-book you have studied and to what extent.]

1. To draw a common tangent to two given circles.

2. The bisector of an angle of a triangle divides the opposite side into segments which are proportional to the adjacent sides.

3. The area of a parallelogram is equal to the product of its base and altitude.

4. How do you find the area of a trapezoid? The areas of similar polygons are to each other in what ratio? Of all plane figures having the same area what one has the least perimeter?

5. If a straight line is perpendicular to each of two straight lines at their point of intersection, it is perpendicular to the plane of those lines.

6. A triangular pyramid is one-third of a triangular prism of the same base and altitude.

7. Define the terms *spherical excess*, and tri-rectangular triangle. The area of a spherical triangle is equal to its spherical excess (the right angle being the unit of angles and the tri-rectangular triangle the unit of areas).

ENGLISH.

JULY, 1880.

1. Parse the words in the following sentences:

(*a*) Many were present who had no desire to change.

(*b*) The wages of sin is death.

2. Name the parts of speech, with an illustrative example of each one.

3. Inflect throughout the pronouns of the first and second persons.

4. Give the principal parts of the verbs *lie*, *lay*, *draw*, *ride*, *thrive*, *set*, *sit*, and *go*.

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ALGEBRA.

JULY, 1880.

[State what text-book you have studied and to what extent.]

1. Resolve the following expressions into factors:
$16a^4b^2-24a^2bmx+9m^2x^2$; $9a^2b^2-16a^2c^2$; a^3-8b^3.

2. Given $\frac{x}{a+b}+\frac{y}{a-b}=\frac{1}{a-b}$ and $\frac{x}{a+b}-\frac{y}{a-b}=\frac{1}{a+b}$; find x and y.

3. Given $\sqrt{a-x}+\sqrt{b-x}=\frac{b}{\sqrt{b-x}}$ to find x.

4. (1) From $2\sqrt{72a^2}$ take $\sqrt{162a^2}$.
(2) Find the value of $\sqrt{2}\times\sqrt[3]{3}\times\sqrt[4]{5}$.
(3) Divide $8a-b$ by $2a^{\frac{1}{3}}-b^{\frac{1}{3}}$.
(4) Simplify $\frac{a^2b}{3c}\left(\frac{a^7b^4}{9c^5}\right)^{-\frac{1}{4}}$.

5. Given $\frac{3x}{2}+4x-8>3$ and $6x+\frac{5x-15}{3}<18$ to find a superior and an inferior limit of x.

II.

6. Given $\frac{x+2}{x-2}-\frac{x-2}{x+2}=\frac{5}{6}$, to find the values of x.

7. Given $x^2+xy=a$, $y^2+xy=b$, to find x and y.

8. Expand $\frac{1+2x}{1-x-x^2}$ into a series by the method of indeterminate coefficients.

9. The number of permutations of n things, 3 together, is 6 times the number of combinations, 4 together; find n.

NOTE.—The first division of the paper extends as far as Quadratic Equations, and will be all that is required of candidates who propose to pass the partial examination only.

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ALGEBRA.

SEPTEMBER, 1880.

1. Divide $\frac{x^4 - b^4}{x^3 - 2bx + b^3}$ by $\frac{x^2 + bx}{x - b}$.

2. Given $\frac{a+4b}{m+x} = \frac{2a-3b}{3m-y}$ and $5ax - 2by = c$ to find x and y.

3. $\sqrt{14-x} + \sqrt{11-x} = \frac{3}{\sqrt{11-x}}$ to find x.

4. Simplify $\sqrt{24} + \sqrt{54} - \sqrt{6}$; $\frac{a+b}{a-b}\sqrt{\frac{a-b}{a+b}}$;

$a\sqrt[m]{x} \times b\sqrt[n]{y} \times c\sqrt[p]{z}$; $(\sqrt{-1})^4$; $(\sqrt[4]{-1})^2$.

5. Extract the square root of $4x^4 + 16a^4 - 12ax^3 - 24a^3x + 25a^2x^2$.

6. Solve the equation $3x^2 + 2x - 9 = 76$.

7. If $\frac{a_1}{b_1} = \frac{a_2}{b_2} = \frac{a_3}{b_3} \ldots = \frac{a_n}{b_n} = r$, show that

$$\frac{a_1 + a_2 + a_3 + \ldots + a_n}{b_1 + b_2 + b_3 + \ldots + b^n} = r.$$

8. Having the first term (a), the ratio (r), and the last term (l), of a geometric progression, find the sum (s) and the number (n) of the terms.

9. Expand $\frac{b}{\sqrt{x^2+a^2}}$ into a series by the binomial formula.

10. Solve the equations $x^y = y^x$, and $x^3 = \frac{1}{4}y^2$.

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TRIGONOMETRY.

JULY, 1880.

[State what text-book you have studied and to what extent.]

1. Given $\tan A = \sqrt{3}$; find all the other functions of A when A is an angle of the 3d quadrant.

2. Given $\sin 30° = \frac{1}{2}$; find the sine and cosine of $\pm 60°$, 120°, 150°, 210°, 240°, 300°, 330°.

3. Deduce the formula $\sin x + \sin y = 2 \sin \frac{1}{2}(x+y) \cos \frac{1}{2}(x-y)$.

4. Show that $\tan^{-1} x - \tan^{-1} y = \tan^{-1} \frac{x-y}{1+xy}$.

5. Write the formulæ for solving the several cases of right triangles.

6. In a plane triangle the side b is 304, the side c 280.3 and the included angle A is 100°. Find the remaining parts.

TRIGONOMETRY.

SEPTEMBER, 1880.

[State what text-book you have studied and to what extent.]

1. The length of an arc is 1.5 that of its radius; what is the number of degrees in the angle it subtends?

2. Find all of the functions of the following angles:

$$\pm 45°, 135°, 225°, 315°.$$

3. Given $\sin A = m \sin B$ and $\tan A = n \tan B$; find $\sin A$ and $\cos B$.

4. Deduce the formulæ for the sine of the sum of two angles in terms of the sines and cosines of the angles.

5. Given $A = \sin^{-1} \frac{3}{5}$, $B = \sin^{-1} \frac{4}{5}$, to show that $A + B = 90°$.

6. In a triangle A B C, given $a = 309$, $b = 450$, and $A = 27° 50'$, to first determine whether the triangle admits of more than one solution, and then solve it.

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LATIN.

JULY, 1880.

I. Translate as literally as possible—

a. Quum ea ita sint, tamen, si obsides ab iis sibi dentur, uti ea, quae polliceantur, facturos intelligat, et si *Aeduis* de injuriis, quas ipsis sociisque eorum intulerint, item si Allobrogibus satisfaciant, sese cum iis pacem esse facturum. Divico respondit: Ita Helvetios a majoribus suis institutos esse, uti obsides accipere, non dare, consuerint; ejus rei populum Romanum esse *testem*.

b. Ibi vadis repertis partem suarum copiarum transducere conati sunt, eo consilio, uti, si possent, castellum, *cui* præerat Quintus Titurius legatus, expugnarent, pontemque interscinderent; si minus potuissent, agros Remorum popularentur, qui magno *nobis usui* ad bellum gerendum erant, commeatuque nostros prohiberent.

c. Impeditis hostibus propter ea, quae ferebant, onera, subito quabus *portis* eruptionem fieri jubet. Factum est opportunitate loci, hostium inscientia ac defatigatione, virtute militum, et superiorum pugnarum *exercitatione*, ut ne unum quidem nostrorum impetum ferrent ac statim terga verterent.

d. Dum in his locis Caesar *navium* parandarum causa moratur, ex magna parte Morinorum ad eum legati venerunt, qui se de superioris temporis consilio excusarent, quod homines barbari et nostrae *consuetudinis* imperiti bellum populo Romano fecissent, seque ea, quae imperasset, facturos pollicerentur.

e. Britanniae pars interior ab iis incolitur, quos natos in insula ipsi memoria *proditum* dicunt; maritima pars ab iis, qui praedae ac belli *inferendi* causa ex Belgis transierant; qui omnes fere iis nominibus civitatum appellantur, quibus orti ex civitatibus eo pervenerunt, et, bello illato, ibi permanserunt atque agros colere coeperunt.

f. Ambiorix copias suas *judicione* non conduxerit, quod proelio dimicandum non existimarit, an tempore exclusus et repentino equitum adventu prohibitus, quum reliquum *exercitum* subsequi crederet, dubium est; sed certe dimissis per agros nuntiis sibi quemque consulere jussit.

II. 1. Decline *obsides* (1), *majoribus* (5), *loci* (16).

2. Compare *imperiti* (22), *interior* (24), *certe* (33).

3. Write the synopsis, active and passive, of *intelligat* (2).

4. State the mood and tense of the following: *consuerint* (6), *præerat* (9), *ferrent* (18), *imperasset* (23), *existimarit* (31).

5. Give the principal parts of the following: *polliceantur* (2), *repertis* (8), *interscinderent* (10–11), *gerendum* (12), *verterent* (18), *incolitur* (24), *orti* (28), *colere* (29), *existimarit* (31), *exclusus* (31), *crederet* (33), *consulere* (34).

6. State the construction of all italicized words.

7. Define indirect statement (*oratio obliqua*), and quote an example from the above text.

8. Convert into direct statement (*oratio directa*) the example quoted in answer to question seventh.

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LATIN.

SEPTEMBER, 1880.

I. Translate as literally as possible—

a. Eadem secreto ab aliis quaerit; reperit esse vera: Ipsum esse Dumnorigem, summa *audacia*, magna apud plebem propter liberalitatem gratia, cupidum rerum novarum: complures *annos* portoria reliquaque omnia Aeduorum vectigalia parvo *pretio* redempta habere, propterea quod, illo licente, contra liceri audeat nemo.

b. Quum ab his quaereret, quae civitates, quantaeque in armis essent et *quid* in bello possent, sic reperiebat: Plerosque Belgas esse ortos ab Germanis, Rhenumque antiquitus transductos propter loci fertilitatem ibi consedisse, Gallosque, qui ea loca incolerent, expulisse.

c. His rebus gestis, quum omnibus de cansis Caesar pacatam Galliam existimaret, superatis Belgis; expulsis Germanis, victis in Alpibus Sedunis, atque ita inita *hieme* in Illyricum profectus esset, quod eas quoque *nationes* adire et regiones cognoscere volebat, subitum bellum in Gallia coortum est.

d. Germanico bello confecto, multis de causis Caesar statuit *sibi* Rhenum esse transeundum; quarum illa fuit justissima, quod, quum videret Germanos tam facile impelli, ut in Galliam venirent, suis quoque *rebus* eos timere voluit, quum intelligerent et posse et audere populi Romani *exercitum* Rhenum transire.

e. Utuntur aut *aere* aut taleis ferreis ad certum pondus examinatis pro nummo. Nascitur ibi plumbum album in mediterraneis regionibus, in maritimis *ferrum*, sed ejus *exigua* est copia; aere utuntur importato. Materia cujusque generis, ut in Gallia, est, praeter fagum atque abietem.

f. Ac fuit antea tempus, quum Germanos Galli *virtute* superarent, ultro bella inferrent, propter hominum multitudinem agrique inopiam trans Rhenum colonias mitterent. Itaque ea, quae fertilissima Germaniae sunt, loca circum Hercyniam silvam, Volcae Tectosages, occupaverunt atque ibi consederunt.

II. 1. Decline *vectigalia* (4), *ea* (11), *hieme* (14).

2. Compare *parvo* (4), *facile* (20), *fertilissima* (31).

3. Write the synopsis, active and passive, of *habere* (5).

4. State the mood and tense of the following: *reperit* (1), *audeat* (6), *videret* (20), *superarent* (28–29), *inferrent* (29).

5. Give the principal parts of the following: *quaerit* (1), *reperit* (1), *audeat* (6), *incolerent* (11), *coortum* (16), *confecto* (17), *impelli* (20), *videret* (20), *intelligerent* (21), *nascitur* (24), *consederunt* (32).

6. State the construction of all italicized words.

7. Define indirect statement (*oratio obliqua*), and quote an example from the above text.

8. Convert into direct statement (*oratio directa*), the example quoted in answer to question seventh.

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LATIN EXERCISES.

JULY, 1880.

1. The Helvetians[1] move[2] (their) camp[3] from[4] this[5] place[6].

2. Cæsar does[7] the same[8] (thing).

3. Cæsar sends-forward[9] all[10] (his) cavalry[11].

4. The cavalry was sent-forward by[12] Cæsar.

5. Cæsar will move (his) camp and[13] send-forward all (his) cavalry.

6. The Helvetians having moved (their) camp[14], Cæsar did the same (thing).

7. Cæsar said[15] he would move his camp.

8. (Rewrite sentence seventh so as to illustrate direct statement).

9. The Helvetians say: "The Roman[16] people[17] is a witness[18]."

10. (Rewrite sentence ninth so as to illustrate indirect statement).

[1] Helvetius.
[2] movere.
[3] castra.
[4] ex.
[5] is.
[6] locus.
[7] facere.
[8] idem.
[9] praemittere.
[10] omnis.
[11] equitatus.
[12] a.
[13] que.
[14] use subjunctive with *cum*.
[15] dicere.
[16] Romanus.
[17] populus.
[18] testis.

LATIN EXERCISES.

SEPTEMBER, 1880.

1. Labienus[1] fortifies[2] the camp[3].

2. The camp is fortified by[4] Labienus.

3. Labienus set-out[5] against[6] the enemy[7].

4. Labienus ascertained[8] the design[9] of the enemy (plural).

5. Labienus, having ascertained[10] the design of the enemy (plural), fortifies (his) camp.

6. Labienus set-out with[10] five[11] cohorts[12].

7. Labienus said[13] he would set-out with five cohorts.

8. (Rewrite sentence seventh so as to illustrate direct statement).

9. Labienus says: "I will move[14] the camp at day-break[15]."

10. (Rewrite sentence ninth so as to illustrate indirect statement).

[1] Labienus.
[2] communire.
[3] castra.
[4] a.
[5] proficisci.
[6] contra.
[7] hostis.
[8] cognoscere.
[9] consilium.
[10] cum.
[11] quinque.
[12] cohors.
[13] dicere.
[14] movere.
[15] prima lux.
[16] use *ablative absolute*.

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HISTORY OF THE UNITED STATES.

JULY, 1880.

1. What territory has the United States acquired by purchase? by conquest? by annexation?

2. State the causes of (1) the French and Indian War; (2) the Revolutionary War; (3) the War of 1812.

3. Arrange the following events in the order in which they occurred, with their dates: admission of California to the Union, assembling of the first Continental Congress, acquisition of Florida, second election of Monroe, opening of the Erie Canal, capture of Atlanta, death of Daniel Webster.

4. What was the Wilmot Proviso?

5. What Vice-Presidents were afterward elected Presidents?

6. Give the names of the opposing political parties in 1800; in 1840; in 1860.

HISTORY OF THE UNITED STATES.

SEPTEMBER, 1880.

1. What territory was granted by James I. to the London Company? to the Plymouth Company?

2. Describe the settlement of Virginia.

3. Arrange the following events in the order in which they occurred, with their dates: surrender of Cornwallis, the admission of West Virginia to the Union, the Whiskey Rebellion, the negotiation of Perry's treaty with Japan, the adoption of the Constitution.

4. When and where was the Confederate Government formed?

5. What was the Compromise of 1850?

6. What President was impeached? What Presidents were elected by the Federalist party?

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GEOGRAPHY.

JULY, 1880.

1. Bound the State of Mississippi; name its larger cities, and tell how they are situated.

2. Where is the Cape of Good Hope; Cape May; Cape St. Lucas; Cape Race?

3. What countries of America border on the Pacific Ocean?

4. Where does the River Rhine rise, run and empty; and what countries does it touch?

5. What countries of Europe touch the Mediterranean Sea?

6. Where are the following cities: Melbourne, Milwaukee, Havre, Valparaiso, Cairo?

GEOGRAPHY.

SEPTEMBER, 1880.

1. Bound the State of Virginia; what are some of its larger cities, and how are they situated? and what are some of the principal rivers in it or on its borders?

2. What states (of the U. S.) border on the Gulf of Mexico? name them in their order, beginning with Texas.

3. Where does the Missouri river rise? describe the direction of its course; what states and territories does it pass through or touch?

4. Where are the following European cities, and how are they situated: Bremen, Venice, Cologne, Havre, Hamburgh?

5. Where are the Aleutian Islands? the Azores? the Bermudas? the Philippines? the Bahamas?

6. Bound British India. Give the names of some of its principal rivers, mountains, and cities, and tell how each is situated.

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SIXTEENTH ANNUAL REPORT

OF THE

SHEFFIELD SCIENTIFIC SCHOOL

OF

YALE COLLEGE,

1881--82.

PRINTED BY ORDER OF THE GENERAL ASSEMBLY.

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REPORT

OF THE

STATE BOARD OF VISITORS.

To the General Assembly:

The State Board of Visitors of the Sheffield Scientific School at Yale College have the honor to transmit herewith the sixteenth Annual Report of the Governing Board. We commend this document to the careful examination of the legislature, for from it can be had acquaintance with the workings and the necessities of one of the most useful and influential educational establishments in which our State has an active interest. It will be seen that the demands upon the capacity and accommodations of the school are steadily increasing. It is in every respect conducted in a manner satisfactory to your visiting board, and we believe that it is doing its important work thoroughly well. Its importance in our practical, industrial community can hardly be over-estimated. It is preparing our youth to maintain and continue that supremacy and advance in industrial pursuits of which the State is proud, and it is at the same time fostering and spreading a love for sound science, and the habit of

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sound methods which must form the true basis for a healthy and permanent continuance of that supremacy. To it also our agricultural population have learned to look for help. In this way it has attached itself intimately with our most vital material interests, while at the same time it has been maintained as a scientific school. We believe that it is fully accomplishing its duty to the State and deserving of the care which the State has bestowed.

HOBART B. BIGELOW,
Chairman.

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ANNUAL STATEMENT

OF THE

GOVERNING BOARD.

In presenting their Sixteenth Annual Report the Governing Board has the gratification of announcing the continued prosperity of the School. The entering class fully equals that of the year preceding which was itself exceptionally large. In particular, the growing interest in science has been evinced for several years past by the increasing number of students who are desirous of receiving instruction in Chemistry. A large share of Sheffield Hall has been devoted to this special branch, but for a long while even that space has been felt to be inconveniently crowded. It will be observed that the number of special students not candidates for a degree is this year fewer than ordinarily. The reason for this is that there was no room in the Analytical Laboratory, the course in Chemistry being the one ordinarily pursued by such students. Several applications to take this course the Board were in consequence under the necessity of declining, because the facilities at their command were not sufficient to enable them to afford the instruction desired. Moreover they have this year entered into an arrangement with the Academic department to furnish instruction in the Analytical Laboratory to six students of that department who wished to take special courses in Chemistry. Application was made for a larger number but the space at the disposal of the School was not sufficient to allow of any more.

Under these circumstances the Governing Board felt themselves compelled to give notice to the Connecticut Agricultural Experiment Station that after this year the rooms occupied by it would be needed for the further extension of the Analytical Laboratory. The Experiment Station has occupied quarters in Sheffield Hall since its establishment in 1877; and were it in their power the Board would gladly continue to furnish as before the free use of

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the rooms it has been occupying. Now that it has been determined to offer still further facilities for the study of Chemistry, it has been deemed advisable to give a full account of this course, with definite statements of its aims and a detailed account of the instruction it affords. During the past three or four years especially its course of study has been considerably modified and it is thought improved. A fuller account of it than can be found in our late annual reports may therefore be of interest to the friends of the School, and to those who are considering which of the several courses offered will best fit them for their proposed future profession or occupation.

The Chemical Course.

The chemical course was one of the first distinct courses of study organized in the School. In the earlier years of its existence, students entered it with a great diversity of aim; for besides its adaptation to the wants of the chemical student, it furnished a partial preparation for the study of agriculture, metallurgy, mining engineering, medicine, pharmacy, and perhaps other professions. The development, during the past twenty years, in the Sheffield Scientific School as well as in other institutions, of courses of study designed especially as a preparation for these professions, has undoubtedly withdrawn from this course many students who would otherwise have entered it. Its classes however have not diminished. There are still many—and the number seems to be increasing—to whom the study of chemistry as a pure science, without regard to its application to industrial pursuits, or its use in other professions, is so attractive that they decide to make it a permanent pursuit, expecting to become instructors or investigators. The especial aim of the course is to meet the requirements of this class of students. Their opportunity for study in schools under the guidance of teachers may end with our undergraduate course, or they may extend it to a graduate course in the Sheffield Scientific School or in other institutions abroad. In either case a like preparation is required for future work. The most indispensable part of this preparation is assumed to be a thorough knowledge of the fundamental principles of chemistry; a familiarity with chemical reaction attainable only by much experience in the laboratory and a careful training in analytical chemistry.

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Besides those having the motives above defined, others may, and in fact do, enter this department of the School with advantage. There is a demand in the country for analytical chemists to fill positions connected with metallurgical or manufacturing establishments. For such as wish to fit themselves for these positions, the course is particularly favorable on account of the liberal amount of time it affords for laboratory practice in chemical analysis. It may also be recommended to those who expect to be actively connected with any manufacturing business which depends largely upon the employment of chemical processes.

The Course of Study.

Chemistry in its different branches is the principal study. The other subjects embraced in the course, which in respect to the amount of time devoted to them may be termed the minor studies, besides contributing something toward a general scientific education, are for the most part connected with the main object of the course. A knowledge of French and German, sufficient to render available the chemical literature of those languages, is indispensable to the advanced student. Mineralogy is so intimately connected with chemistry that it may properly be termed the chemistry of natural inorganic compounds, while a knowledge of the more important elements, or outlines of geology, may be considered of sufficient value in itself to repay the student for the moderate amount of time required for its acquisition.

The Freshman Year being designed to fit the student equally well for any of the courses which he may choose at the beginning of the Junior year, must necessarily include some studies which are not absolutely indispensable as a foundation to his future course. The Chemistry, Physics, German and in part the Mathematics of this year may be regarded as strictly preparatory to the chemical course.

Junior Year. During the greater part of this year instruction is given by means of text-books and recitations in chemical philosophy or "theoretical chemistry;" this may be considered as a continuation of the elementary chemistry studies during the Freshman year. Throughout the year the student spends four consecutive hours in the chemical laboratory five days of every week. On one day of the week exercises in Mineralogy take the place of Chemistry. The laboratory study is devoted to a systematic

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course in analytical chemistry except during a part of the summer term in which analytical chemistry is replaced by experimental work in organic chemistry; this work consists of the preparation by synthetic methods of a series of organic compounds and is designed as a preparation for the systematic study of that branch of Chemistry which is carrried on during the Senior year. French and German are studied throughout the year.

Senior Year. During this year also about four hours daily are given to the study of analytical chemistry in the laboratory. At the end of the first term the student is familiar with the most important general analytical methods. The subject of his laboratory work during the second term is to a great extent optional. He may, if desirous, gain experience in the assaying of ores or analysis of some particular class of products with a view to its technical application; or he may devote his time to original research on some subject of scientific interest. Not less important, although requiring less time, is the study of organic chemistry. On account of the lack of a suitably organized laboratory for organic chemistry, experimental work, which under favorable circumstances would be highly desirable, is not carried on in connection with this study during the senior year. Lectures in zoology are attended during the first term and recitations in geology during the year. These exercises, together with three lessons weekly in French, fully occupy the time not required for chemical studies.

Method of Instruction.—In most of the studies of the course, instruction is given by means of text-books and recitations in the usual manner which requires no particular explanation. In regard to analytical chemistry, to which more time is allotted than to any other single branch of study in the course, it may be observed that it is intended to serve two purposes. It is to be used by the advanced student as a means of investigation in scientific or technical researches. The beginner, however, derives from its study advantages of another kind. The knowledge of the properties of chemical compounds, and familiarity with chemical reaction gained by experience in the laboratory, and the development of the reasoning faculties by the application of this knowledge in analytical processes, enables the student to generalize and classify chemical phenomena and it aids him to understand the more abstract theories of chemical philosophy. The method of instruction adopted is conformed to this view of the uses of the study. Text-books are used and recitations are required, but the more

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important part of both study and instruction is performed in the laboratory. In order to solve the problems which are thus presented, the student, aided by books and instructors, must learn both principles and their application.

Chemistry for Graduate Students.

The School has been constantly increasing the facilities which it offers to graduate students for the study of different branches of chemistry. The laboratories for analytical and physiological chemistry are open seven hours daily for their use.* They may begin with a course in quantitative analysis or with more advanced work, according to their previous preparation. Each one receives separately in the laboratory all assistance necessary to enable him to advance in proportion to his ability and diligence. Recitations in quantitative analysis accompany laboratory work during the first term of the year. Graduates may also, if desirous, attend any of the recitations or exercises belonging to the above described chemical course. After suitable preparation the undertaking of original investigations is encouraged. (The work of this kind carried on in our laboratories has afforded, it is believed, the most valuable training possible for the student and has often resulted also in the production of contributions to science of considerable value.)

The Chemical Laboratories of the School

may be designated according to their special uses as follows:

1. A Laboratory for Elementary Chemistry, used exclusively for instruction of the Freshman class.
2. A Laboratory for Qualitative Analytical Chemistry.
3. A Laboratory for Quantitative Analytical Chemistry and various chemical investigations.
4. A Laboratory for Physiological Chemistry.

An additional room in the basement of Sheffield Hall is fitted up with furnaces and apparatus necessary for assaying of ores in the dry way, while the practice required in Determinative Mineralogy is carried on in a laboratory arranged especially for this purpose in the Peabody Museum.

*Details concerning instruction in physiological chemistry, which forms an important part of the course in Biology, may be found in the Annual Report for 1877–1878.

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These laboratories are all satisfactorily supplied with apparatus and fixtures necessary for carrying on the work for which they are designed, but some of them are deficient in space. At the present time the laboratories for analytical and physiological Chemistry are occupied by forty-one students. Of these, thirty are undergraduates in the courses of Chemistry, Biology and Agriculture, eight are graduates and three are special students. They are working four hours daily under the supervision of four instructors. The combined capacity of the three rooms which they occupy, however, is quite insufficient to accommodate conveniently so large a number. To obviate these disadvantages which have been increasing every year, it is now determined, as stated above, to fit up the rooms which have been used hitherto by the Agricultural Experiment Station. These, it is expected, will be ready for occupancy at the beginning of the next Academic year.

Changes in the Corps of Professors.

It is with great regret that the Board are under the necessity of chronicling the loss of Professor Francis A. Walker, who has given up the position he held in this institution to accept the presidency of the Massachusetts Institute of Technology. Professor Walker has been connected with the school since 1871, though during the past two years his duties as Superintendent of the Census have not permitted him to give instruction. In the new and wide field of labor to which he has been called, the wishes of none will be more ardent for his success that those of his old associates in the Governing Board.

The place made vacant by Professor Walker's resignation has been filled by the choice of Professor Henry W. Farnam. Mr. Farnam was a graduate of the Academical Department of the class of 1874. After graduation he pursued a course of study in political economy and history at New Haven, and then went to Germany. He there studied for several years in various universities and finally took his degree in the faculty of law and political science at Strasburg. After his return in 1878 he acted as tutor in the Academical Department, and in 1880 was appointed University Professor of Political Economy.

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Public Lectures.

The fifteenth annual course of lectures to mechanics and others was given during the past year in the lecture room in North Sheffield Hall. The lecturers and the subjects are indicated in the following program:

I.	Thursday, Feb. 10.	—The Mississippi Jetties.	Prof. Brewer.
II.	Tuesday, " 15.	—Life, from a Chemical Point of View.	Dr. R. H. Chittenden.
III.	Thursday, " 17.	—Chocolate.	Prof. Daniel C. Eaton.
IV.	Tuesday, " 22.	—The Laocoön.	Prof. D. Cady Eaton.
V.	Thursday, " 24.	—Histriomastix, and the State Trials of William Prynne.	Prof. Lounsbury.
VI.	Tuesday, Mar. 1.	—Prof. Trowbridge's Coil Boiler.	Mr. F. R. Honey.
VII.	Thursday, " 3.	—The Bunsen Lamp, and Heating by Gas.	Dr. H. P. Armsby.
VIII.	Tuesday, " 8.	—Our own Family of Languages.	Prof. Whitney.
IX.	Thursday, " 10.	—The Structure and Germination of Seeds.	Dr. E. H. Jenkins.
X.	Tuesday, " 15.	—Deep-Water Life off the U. S. Coast.	Prof. Verrill.
XI.	Thursday, " 17.	—Public Parks.	Prof. Baldwin.
XII.	Tuesday, " 22.	—Radiant Matter.	Prof. Lyman.

Lectures on Military Science.

A course of Lectures on Military Science, by officers of the U. S. Engineering School, at Willets Point, was delivered in North Sheffield Hall as a part of the instruction in the School during the second term of the academic year 1880–81. The order and subjects of the Lectures were as follows:

I.	Monday, Feb. 21.	—Strategy and Grand Tactics.	Lieut. G. McC. Derby, U. S. Engineers.
II.	Friday, " 25.	—Logistics.	Lieut. F. V. Abbot, U. S. Engineers.
III.	Monday, " 28.	—Small Arms and their influence on Tactics.	Lieut. Eugene Griffin, U. S. Engineers.
IV.	Friday, Mar. 4.	—Artillery.	Capt. J. B. Quinn, U. S. Engineers.
V.	Monday, " 7.	—Fortification.	Capt. A. M. Miller, U. S. Engineers.
VI.	Friday, " 11.	—Sea Coast Defence.	General H. L. Abbot, U. S. Engineers.

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Additions to the Zoological Collections.

A. E. Verrill, Curator; J. H. Emerton, Assistant.

During the past year, as in previous seasons, the most important additions to the Zoological collections have been due to the coöperation of the curator with the U. S. Fish Commission in the exploration of the sea-bottom, off our coasts.

The headquarters of the Commission were at Wood's Holl, Mass., last season, and the work of dredging and trawling was carried on with great success from that point over an extensive region, both in the shallower waters and southward to the Gulf Stream slope, from 70 to 115 miles off shore, and to a depth of 600 fathoms.

This year, as last, the steamer "Fish Hawk," of 480 tons, built and fitted expressly for the scientific work of the Fish Commission, was employed in these explorations. The commander, Lieut. Z. L. Tanner, U. S. N., also made another trip, after the regular work of the season was over, to the deep-water off the mouth of Delaware Bay, with excellent results. The very extensive and valuable series of Invertebrata, obtained during these explorations, as well as numerous collections contributed to the Fish Commission by the bank fishermen of Gloucester, Mass., have all been sent to the Museum to be elaborated and reported upon, and eventually to be distributed. As fast as they are worked up, good series will be deposited in the Museum.

In the explorations, last summer, the curator was assisted by Mr. Richard Rathbun, Mr. Sanderson Smith, Mr. J. H. Emerton, Professor L. A. Lee, and by Messrs. B. F. Koons, E. A. Andrews, and H. L. Bruner of the Sheffield Scientific School. Professor S. I. Smith also took part in the work during the season, devoting his time to the Crustacea.

Professor Smith has, as usual, taken charge of the Crustacea in the Museum. He has prepared for publication in the Bulletin of the Museum of Comparative Zoology accounts of the numerous new and strange forms of Crustacea, dredged in the deep water, off our coast, by Mr. A. Agassiz on the "Bache," in 1880.

The curator has published papers in the American Journal of Science, giving accounts of numerous new and interesting fishes, mollusca, echinoderms, etc., dredged in the deep water, off the coast. He has also printed in the Transactions of the Connecti-

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cut Academy, vol. v, the second part of a monographic revision of the Cephalopods of our coast, and a lengthy report on the same subject in the Report of the U. S. Fish Commission. These papers are very fully illustrated.

Mr. J. H. Emerton, in addition to his regular duties, has made many drawings to illustrate several of the reports referred to above, and others in progress. He has also been engaged, for some time, upon a life-sized restoration of one of the gigantic Cephalopods of Newfoundland (*Architeuthis princeps*), for exhibition in the Museum. This is now nearly completed. When finished, it will be one of the most remarkable and instructive objects on exhibition.

Miss K. J. Bush has been employed, during the year, at the expense of the U. S. Fish Commission, to aid the curator in arranging and cataloguing the extensive collections that have accumulated, year after year, in connection with the explorations along our coast.

Miss Belle Voorhees has also been employed, in the same way, during a part of the year.

Aside from the collections referred to above, the most interesting and important addition made to the Museum, is a series of mounted birds from New Guinea, presented as a memorial of Charles A. Heald, of the class of 1881 (Y. C.), by his parents. This collection includes a series of four specimens of a recently discovered and rare, as well as beautiful, paradise-bird, the *Paradisea Raggiana*. Many other beautiful specimens are also contained in this collection, and nearly all were previously unrepresented in the Museum.

A small, but valuable, collection of rare bird skins from the high lands of Guatemala, has been presented by Mr. Guillesmo Nanne, through Mr. G. M. Totten.

Several large skins of mammals, birds and sharks have recently been mounted and put on exhibition. Among these is a very large white bear from Siberia, presented several years ago by Mr. Colin M. Ingersoll.

The following are other additions:

Richard Rathbun, specimens of Renilla, Gorgoniæ, and Antedon, from Brazil.

Professor T. A. Thacher, pelican from San Rafael, California. Collected by Albert E. Kent (Y. C. 1853).

Mrs. Peckham, singular nest of Oriole.

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John P. Keep, Hamden, Cross-gray fox. Taken between Hamden and Bethany. (Purchased.)

H. Van Rensselaer (S. S. S.), internal parasites of fox, etc. *Trichinæ* encysted in human muscles, from New York.

Wesleyan University, northern squids (*Ommastrephes*), from Newfoundland, collected by Mr. H. L. Osborn. (In exchange.)

E. B. Wilson (S. S. S. 1878), large specimens of *Balanoglossus*, and of *Chætopterus pergamentaceus*, from Beaufort, N. C.

S. F. Clark (S. S. S. 1878), lancelets (*Amphioxus*), from Chesapeake Bay.

Professor W. K. Brooks, alcoholic specimens of *Lingula pyramidata*, from Rip Raps, Va.

Geo. W. Potter, North Haven, five living black snakes.

H. L. Bruner and E. A. Andrews (S. S. S.), living striped snakes, black snake, and turtles.

C. A. Houghton, W. Medway, Mass., tiger-cat, two species of agouti, duck, crocodile, and large lizard, mounted, from South America. (Presented.) Canada porcupine from Massachusetts, and western fox-squirrel, mounted. (Purchased.)

Dr. J. Jullien, Paris, Bryozoa and shells. (In exchange.)

A. P. Goodwin, shells from Australia, etc. (In exchange.)

B. F. Koons and E. A. Andrews (S. S. S.), lot of *Artemia fertilis*, West Haven.

N. Vickary, Lynn, Mass., birds, mounted, from Massachusetts. (Purchased.)

Professor B. Silliman, forty-nine bird-skins, from California, collected by E. F. Lorquin.

A. E. Verrill, birds and mammals, mounted, from Massachusetts. (Deposited.) Shells, insects, spiders, myriapods, from Wythe Co., Va.

National Museum. A very large shell (*Fusus Arnanus*); a fresh specimen of the recently discovered "tile-fish" (*Lopholatilus*); mounted by Mr. Vickary.

Museum of Havre, France, through M. Auguste Briand. Specimens of cuttle-fishes (*Sepia officinalis* and *Loligo vulgaris*). (In exchange.)

T. S. Gold, West Cornwall. Snake with two heads; fœtal lamb, etc.

Thos. Trowbridge, New Haven. Collection of shells from St. Christopher, W. I. Three large crabs, from West Indies.

Howard Hitchcock. Young turtle (*Ozotheca odorata*).

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G. F. Allen, New Haven. Collection of local land and fresh-water shells.

A. E. Van Name. Menobranchus from near Independence, Wis.

Horace Bowman, New Haven. Rare fish and *Squilla empusa*, Long Island Sound.

Wm. Fuller, New Haven. Specimen of *Squilla*.

Professor B. G. Wilder, Ithaca, N. Y. By exchange. Living mud fish (*Amia calva*) and Menobranchi from Cayuga Lake. In alcohol, *Menobranchus*, young of *Lepidosteus* and *Amia; Amphioxus* from the Mediterranean.

Captain Fred. Hotchkiss. Porcupine-fish (*Tetradon*), from West Indies.

Captain Joseph A. McLure, through Thos. Trowbridge, Jr. Lizard from Dominica; pair of Hercules beetles.

F. S. Smith (Y. C. 1874), New Haven. Internal parasites of Canada Porcupine, Lewis Co., N. Y.

V. N. Edwards, Wood's Holl, Mass. Parasites of eels.

Gen. G. K. Warren, U. S. A. Mud containing shells, dredged up in New Bedford Harbor. Among the shells is *Pholas costata*.

Guillesmo Nanne, Costa Rica, through G. M. Totten. Collection of bird skins from Guatemala.

Anniversary.

The Exercises of the Graduating Class were held in North Sheffield Hall on the evening of Tuesday, June 28, 1881. The candidates for degrees with the subjects of their graduation theses are given in the following schedule. Those marked with an asterisk were read in the evening.

Bachelors of Philosophy. (43).

Charles Francis Adams (Dynamic Engineering), *Jessups, Md.* On the Hydraulics of a Steam Launch, with Design for propelling the same.

Ethan Allen Andrews (Natural History), *Tarrytown, N. Y.* On the Anatomy of the Spider-Crab (*Libinia emarginata*).

Edward Bailey, Jr. (Dynamic Engineering), *Harrisburg, Pa.* Design for a Direct-acting Steam Crane.

Frank Lewis Bigelow (Dynamic Engineering), *New Haven.* On the Colt Disc Engine.

George Frederick Bosworth (Civil Engineering), *Milford.* On English *vs.* American Bridge Building.

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*Lester Paige Breckenridge (Dynamic Engineering), *Westfield, Mass.* On the Methods of Measuring Motive Power.

Charles Sheldon Burnham (Dynamic Engineering), *Woodbridge.* Original Design for an Expansion Gear.

*Howard Field Chappell (Chemistry), *Chicago, Ill.* On the Reaction of Phosphoric Acid with Sodium Chloride.

Charles Manville Downs (Biology), *New Haven.* On the Histology of the Alimentary Canal of the Cat.

*John Slade Ely (Biology), *New York City.* On the Exoskeleton of *Talorchestia longicornis.*

George Sherman Folsom (Select), *Northford.* On International Copyright.

Seymour Francis Frasick (Biology), *Hartford.* On the Exoskeleton and Nervous System of *Crangon vulgaris.*

Albert Moses Gerstle (Select), *Youngstown, O.* On the Anti-Jewish Agitation in Germany.

*Henry Holbrook Gladding (Civil Engineering), *New Haven.* On the Superstructure of the East River Bridge.

*William Loomis Griswold (Biology), *Banksville.* On the Influence of Acids and Alkalies on the Diastatic Action of Saliva.

Frederic Jonathan Hiller (Chemistry), *Cohoes, N. Y.* On the Coloring Matter of Young Fustic.

Samuel Higgins (Dynamic Engineering), *Buffalo, N. Y.* On the History of the Locomotive.

Blain Jamison (Select), *New Orleans, La.* On the Protective System in the United States.

Jeme Tien Yow (Civil Engineering), *Canton, China.* Review of a Large Wharf Crane.

Benjamin Franklin Koons, B.A., Oberlin College (Natural History), *Sulphur Springs, O.* On the Structure of a Phyllopod Crustacean (*Eubranchipus vernalis*).

Edmund Parker Lord (Dynamic Engineering), *Saxonville, Mass.* On the Steam Boiler, and Boiler Explosions.

Richard Beeker Lyon (Civil Engineering), *New Haven.* Discussion of the Roof of the Insurance Building at New Haven.

Silas Metzger (Select). *New Haven.* On the Life-Saving Service of the United States.

Edwin Kirtland Morse (Civil Engineering), *Poland, O.* Review of a Bridge at Struthers, Ohio.

Marcus Daty Munn (Chemistry,) *Southington.* On the Determination of Manganese in Silicates.

Marvin Olcott (Dynamic Engineering), *Corning, N. Y.* On the Steam Engine Governor.

Owyang Keng (Dynamic Engineering), *Canton, China.* On the Steam Indicator.

Francis Stuyvesant Peabody (Select), *Chicago, Ill.* On the Taxation of Mortgages.

Oliver Phelps (Select), *Canandaigua, N. Y.* On the Relation of Railroads to the Prosperity of the Country.

Addison Alexander Righter (Dynamic Engineering), *Newark, N. J.* Design for a Calorimeter for Determining the Amount of Moisture in Steam.

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GEORGE LEWIS SARGENT (Dynamic Engineering), *New Haven.* Report of a Series of Trial Tests upon a Wheelock Engine of One Hundred and Fifty Horse Power.

LOUIS JACOB SCHILLER (Chemistry), *New Haven.* On Volumetric Methods for Determination of Iron.

BERNARD JOSEPH SHANLEY (Select). *New Haven.* On the Navigation Laws.

FRANK AUGUSTUS SMITH (Select), *New Haven.* On Free Ships.

JOHN HEYWARD TRUMBULL (Biology), *Tulcahuano, Chili.* On the Histology of Bone and Teeth.

RICHARD LINDSAY TRUMBULL (Biology), *Talcahuano, Chili.* On the Influence of Bile upon the Products of Digestion.

HOWARD VAN RENSSELAER (Biology), *Albany, N. Y.* On the Exoskeleton of *Amaurobius Americanus*, a new species of *Araneina.*

FRANK CHARLES WARNER (Civil Engineering), *West Suffield.* On the Water Supply of Westfield, Mass.

ROBERT WILLIAM WATSON (Dynamic Engineering), *Ashtabula, O.* On the Perpetual Motion, with a Discussion of Gamgee's "Zero-Motor."

*WILLIAM MEEKER WOOD (Dynamic Engineering), *Morristown, N. J.* On the Mechanical Theory of Heat.

*ARTHUR BURNHAM WOODFORD (Select), *West Winsted.* On the Proposed American Inter-Oceanic Canal.

CLARK WRIGHT (Biology), *West Roxbury, Mass.* On the Histology of the Alimentary Canal of the Shad (*Alosa sapidissima*).

*WILLIS BENTON WRIGHT (Civil Engineering). *Cromwell.* On Compressed Air as applied to Engineering Constructions.

PRIZES.

The following prizes were awarded during the year:

CLASS OF 1881.

For excellence in Civil Engineering, the prize divided between GEORGE FREDERICK BOSWORTH, of *Milford*, and HENRY HOLBROOK GLADDING, *New Haven.*

The Belknap Prize for excellence in Zoological and Biological studies, awarded to ETHAN ALLEN ANDREWS, of *Tarrytown, N. Y.*

CLASS OF 1882.

For excellence in the Mathematics of Junior Year, the prize awarded to FRANK JUDSON LAMBERT, *New Haven.*

CLASS OF 1883.

For excellence in all the Studies of Freshman Year, the prize awarded to EDWARD BRADFORD DENCH, *Bridgeport*, with honorable mention of JOHN BARTHOLOMEW, *Guilford*, and FREDERIC ELIJAH BEACH, *New Haven.*

For excellence in Mathematics, the prize awarded to JOHN ALPHEUS ALLEN, *New Haven*, with honorable mention of JOHN BARTHOLOMEW, *Guilford*, FREDERIC ELIJAH BEACH, *New Haven*, and EDWARD BRADFORD DENCH, *Bridgeport.*

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For excellence in German, the prize awarded to EDWARD BRADFORD DENCH, *Bridgeport*.

For excellence in Physics, the prize divided between JOHN ALPHEUS ALLEN, *New Haven*, and EDWARD BRADFORD DENCH, *Bridgeport*.

For excellence in Chemistry, the prize awarded to JOHN ALPHEUS ALLEN, *New Haven*, with honorable mention of JOHN BARTHOLOMEW, *Guilford*, and EDWARD BRADFORD DENCH, *Bridgeport*.

For excellence in Mechanical Drawing, the prize awarded to CHARLES SUMNER BROWN, *East Hampton*, with honorable mention of JOHN BARTHOLOMEW, *Guilford*, FREDERIC ELIJAH BEACH, *New Haven*, and JOSEPH ALLEN SKINNER, *Holyoke, Mass.*

For excellence in English Composition, first prizes awarded to GEORGE ANDREW BARROWS, *Philadelphia, Pa.*, EBENEZER HUBBARD SKINNER, *Escambia, Fla.*, and ROBERT HAWTHORNE WYLIE, *Chester, S. C.*; second prizes awarded to THEODORE DAVENPORT BACON, *Norwich*, EDWARD BRADFORD DENCH, *Bridgeport*, WILLIAM HARPER, *Shippensburgh, Pa.*, JOHN ELMER LOCKWOOD, *Stamford*, JOHN EDMUND NEWELL, *Chicago, Ill.*, GEORGE SHIPMAN PAYSON, *Chicago, Ill.*, and EDWARD IRVING STONE, *Bethlehem*.

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PROGRAMME OF STUDIES,

AND

CATALOGUE,

FOR THE COLLEGE YEAR 1881-2.

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CALENDAR.

1881.		
15 Sept.	Thursday,	First Term begins.
22 Dec.	Thursday,	First Term ends.
1882.		**Winter Vacation of three weeks.**
12 Jan.	Thursday,	Second Term begins.
5 April,	Wednesday,	Spring Recess begins.
12 April,	Wednesday,	Spring Recess ends.
27 June,	Tuesday,	Meeting of Appointing Board.
27 June,	Tuesday,	Anniversary.
28 June,	Wednesday,	Commencement.
29, 30 June,	Thursday,	Examination for Admission.
1 July,	Friday, Sat.,	
		Summer Vacation of eleven weeks.
12, 13 Sept.	Tues., Wedn.,	Examination for Admission.
14 Sept.	Thursday,	First Term begins.
21 Dec.	Thursday,	First Term ends.

ABBREVIATIONS.

S. H.	Sheffield Hall.
N. S. H.	North Sheffield Hall.
TR.	Treasury Building.
D.	Durfee College.
F.	Farnam College.
E.	East Divinity Hall.
W.	West Divinity Hall.
P. M.	Peabody Museum.
A.	Absent on leave.

In the buildings belonging to the Sheffield Scientific School, the rooms numbered from 1 to 21 are in Sheffield Hall; from 26 to 58 in North Sheffield Hall.

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Comparative Anatomy. (14 P. M.) 148 College st.

WILLIAM G. MIXTER,
Chemistry. (8 S. H.) 8 Trumbull st.

A. JAY DUBOIS,
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Political Economy and History. 43 Hillhouse av.

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Ethan Allen Andrews, PH.B.	*Tarrytown, N. Y.*	N. S. H.
Edward Bailey, PH.B.	*Harrisburg, Pa.*	489 Chapel st.
Gregory Carleton, A.B. Amherst College.	*Amballa, India.*	215 York st.
John Slade Ely, PH.B.	*New York City,*	57 N. S. H.
Charles Hildebrand, D.E.	*New Haven,*	34 Chestnut st.
Alfred Edwards Hooker, B.A.	*New Haven,*	62 Prospect st.
Joseph Frederick Klein, D.E.	*New Haven,*	14 Whalley av.
Samuel Waldron Lambert, B.A.	*New York City,*	90 High st.
Sarkis Levonian, Central Turkey College.	*Aintab, Turkey,*	72 High st.
George Sigmund Linde, B.A.	*New Haven,*	133 Congress av.
Edwin Linton, M.A. Washington and Jefferson College, Pa.	*Washington, Pa.*	49 Grove st.
Marcus Daty Munn, PH.B.	*Southington,*	55 N. S. H.
Harold Bayless Nye, B.A. Marietta College.	*Marietta, O.*	91 W.
Samuel Lucius Penfield, B.A.	*Catskill, N. Y.*	14 S. H.
Frank Charles Warner, PH.B.	*West Suffield,*	305 Orange st.
Frank Hyde Waters, B.S. Eminence College, Ky.	*Garrettsville, O.*	21 Home pl.
Robert William Watson, PH.B.	*Ashtabula, O.*	498 Chapel st.
Arthur Burnham Woodford, PH.B.	*West Winsted,*	16 S. H.
George Woolsey, B.A.	*New Haven,*	250 Church st.

GRADUATES, 19.

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SENIOR CLASS.

Horace Ellsworth Andrews,	*Cleveland, O.*	43 College st.
Alfred Warner Armstrong,	*Cleveland, O.*	43 College st.
Charles Noyes Batcheller,	*Wallingford, Vt.*	114 High st.
Henry Jonathan Biddle,	*Philadelphia, Pa.*	36 Elm st.
Francis Hayes Blake,	*New Haven,*	119 W.
Nathan Gross Bozeman,	*New York City,*	31 Temple st.
Frederick Casper,	*West Meriden,*	215 York st.
William Anson Chamberlin,	*New Haven,*	30 Trumbull st.
William Henry Crocker,	*San Francisco, Cal.*	36 Elm st.
James John Drummond,	*Winfield, Ill.*	114 High st.
Richard Lawrence Everit,	*New Haven,*	281 Whitney ave.
Herbert Waldron Faulkner,	*Stamford,*	23 Prospect st.
William Alanson Hall,	*Morris,*	106 Wooster st.
Alexander Bryan Johnson,	*Utica, N. Y.*	62 W.
Frederick William La Forge,	*Waterbury,*	167 Temple st.
Frank Judson Lambert,	*New Haven,*	12 Eld st.
Norman Smith Latham,	*North Manchester,*	120 Dwight st.
Cassius Samuel Lyman,	*Holyoke, Mass.*	67 Mansfield st.
Sheldon Elton Minor.	*Thomaston,*	167 Temple st.
Edward E. Paramore,	*St. Louis, Mo.*	36 Elm st.
Louis Valentine Pirsson,	*New York City,*	121 Park st.
Harry Smith Pope,	*Jersey City, N. J.*	61 W.
Robert Browning Rood,	*Great Barrington, Mass.*	167 Temple st.
Charles Edward Stockder, Jr.	*West Meriden.*	167 Temple st.
Fred Moore Strong,	*Boston, Mass.*	36 Elm st.
Henry Taber.	*New York City,*	33 Prospect st.
Arthur Graham Thompson,	*Milford,*	43 College st.
Edwin Thorne,	*New York City,*	62 W.
Thomas Pearsall Thorne,	*Millbrook, N. Y.*	71 W.
Walter Joy Vought,	*Buffalo, N. Y.*	85 W.
Edward Loder Whittemore,	*Rye, N. Y.*	76 W.
Alfred Buckingham Willcox,	*Chicago, Ill.*	76 W.
Chauncey Pratt Williams, Jr.	*Albany, N. Y.*	36 Elm st.
S. Lawrence Williams,	*Chicago, Ill.*	36 Elm st.

SENIORS, 34.

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JUNIOR CLASS.

Paul Whitin Abbott,	*New Haven*,	257 Church st.
John Alpheus Allen,	*New Haven*,	189 Temple st.
Benjamin Safford Barrows,	*Hartford*,	163 Temple st.
George Andrew Barrows,	*Philadelphia, Pa.*	43 College st.
John Bartholomew,	*Guilford*.	17 Wooster pl.
Frederic Robinson Bartlett.	*Freeport, Ill.*	36 Elm st.
Frederick Elijah Beach,	*New Haven*,	33 Lyon st.
Henry Whitney Berryman,	*New York City*,	464 Chapel st.
Isaac Judson Boothe,	*Birmingham*,	143 York st.
Charles Allan Bowles,	*Springfield, Mass.*	167 Temple st.
Frederick Truman Bradley,	*New Haven*,	142 Orange st.
Charles Parker Breese,	*Meriden*,	458 Chapel st.
Charles Sumner Brown,	*East Hampton*,	114 High st.
Charles Milo Carpenter,	*Madison, Wisc.*	36 Elm st.
Horace Raymond Carpenter,	*Afton, N. Y.*	60 w.
Samuel Myron Chase,	*Chicago, Ill.*	184 York st.
John Lindley Coates,	*Kansas City, Mo.*	66 w.
Harry Nelson Covell,	*Stamford*,	31 Temple st.
Wayne Darlington,	*West Chester, Pa.*	136 College st.
Edward Bradford Dench,	*Bridgeport*,	67 Mansfield st.
Henry Kelsey Devereux,	*Cleveland, O.*	43 College st.
Robert Ogden DuBois,	*New Haven*,	328 Howard av.
Edward Peers Eastwick, Jr.	*New York City*.	36 Elm st.
Horatio Southworth Frazer,	*Holyoke, Mass.*	77 w.
Charles Lockwood Gold,	*West Cornwall*,	49 Grove st.
Charles Stewart Hall,	*Warren, O.*	36 Elm st.
George Vance Harper.	*Denver, Col.*	41 Trumbull st.
William Harper,	*Shippensburg, Pa.*	136 College st.
Allen Hubbard,	*Westfield, Mass.*	114 High st.
Henry Clay Johnson,	*Rome, Ga.*	41 High st.
John Elmer Lockwood,	*Stamford*,	146 Dixwell av.
William Ellison Lockwood,	*Stamford*,	146 Dixwell av.
James Lyman,	*Middlefield*,	107 w.
John Lyman,	*Middlefield*,	107 w.
John Henry Mann,	*Utica, N. Y.*	43 College st.
Donald Grant Mitchell, Jr.	*Edgewood*,	134 College st.
John Edmund Newell,	*Chicago, Ill.*	73 w.
Henry Curtis Nutt, Jr.	*Boston, Mass.*	36 Elm st.
George Shipman Payson,	*Chicago, Ill.*	109 Wall st.
Edward Wells Penfield,	*Chicago, Ill.*	109 Wall st.
James Edward Pope, Jr.	*Jersey City, N. J.*	61 w.
David Murdoch Pratt,	*Elmira, N. Y.*	36 Elm st.
Willie Sherman Randall,	*Birmingham*,	72 High st.

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Albert William Robert,	*New York City*,	36 Elm st
Joseph Warren Rogers, Jr.	*Scarborough, N. Y.*	203 York st.
Frederick Baylies Samson,	*Richmond, Ind.*	458 Chapel st.
Charles Lansing Sayre,	*Utica, N. Y.*	43 College st.
Horace Lee Simpson,	*Pensacola, Fla.*	114 High st.
Ebenezer Hubbard Skinner,	*Escambia, Fla.*	114 High st.
Joseph Allen Skinner,	*Holyoke, Mass.*	106 Wall st.
Edward Irving Stone,	*Bethlehem*,	72 High st.
John Edwards Stryker,	*Catskill, N. Y.*	77 w.
Alonzo Felton Wood, Jr.	*West Haven*,	77 George st.
Alexander Wurts,	*New Haven*,	65 Whitney av.
Robert Hawthorne Wylie,	*Chester, S. C.*	136 College st.

JUNIORS, 55.

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FRESHMAN CLASS.

Gustavo Alfonso,	*New York City,*	36 Elm st.
Elwood Harvey Allcutt,	*Kansas City, Mo.*	66 w.
Charles Law Allen,	*New Haven,*	38 Eld st.
Richard Mayes Anderson,	*Mayfield, Ky.*	347 York st.
John Ogden Armour,	*Chicago, Ill.*	200 York st.
Henry Dudley Barry,	*Constantine, Mich.*	36 Elm st.
Frank Allen Benedict,	*Bethel,*	494 Chapel st.
Lawrence Vincent Benét,	*Washington, D. C.*	74 High st.
Edward Blake,	*New Haven,*	149 Temple st.
Charles Francis Bosworth,	*Milford,*	285 York st.
Clarence Russell Britton,	*Cleveland, O.*	128 High st.
Chauncey Rea Burr,	*Portland, Me.*	420 Chapel st.
Albert Park Campbell,	*New Haven,*	16 York sq.
Herbert DeWitt Carrington,	*New Haven,*	527 Chapel st.
Harold Austin Chambers,	*New York City,*	94 Grove st.
William Brainard Coit,	*New London,*	44 Elm st.
Clifford Lawrence Colton,	*Canton,*	347 York st.
Louis Edward Cooper,	*Ansonia,*	25 Prospect st.
Samuel Joseph Cornell,	*New York City,*	489 Chapel st.
George Wyckoff Cummins,	*Vienna, N. J.*	347 York st.
Walter Rowling Dann,	*New Haven,*	280 Ferry st.
Benjamin Wales Dodge,	*Middlebury, Vt.*	221 Elm st.
Edward Bailey Downing,	*Wilmington, Del.*	44 Elm st.
Charles Percival Farquhar,	*York, Pa.*	27 Prospect st.
James Arthur Fawcett,	*Cleveland, O.*	128 High st.
Arthur Bixby Ferguson,	*New Haven,*	539 Howard av.
Davenport Galbraith,	*Erie, Pa.*	489 Chapel st.
John Chidsey Grout,	*Detroit, Mich.*	161 Temple st.
Morgan Augustus Guinnip,	*Elmira, N. Y.*	494 Chapel st.
Pelham Hague,	*Tidioute, Pa.*	31 Trumbull st.
Calvin Linsley Harrison,	*New Haven,*	139 Greene st.
John Bell Hatcher,	*Jefferson, Ia.*	12 Elm st.
Samuel Brown Hawley,	*Yonkers, N. Y.*	139 Chapel st.
James H. Hepburn,	*Jersey Shore, Pa.*	74 High st.
Edwin Musser Herr,	*Denver, Col.*	289 York st.
Charles Henry Hopper,	*Cleveland, O.*	128 High st.
James Henry Jennings,	*Redding,*	215 York st.
Thomas Crossley Johnson,	*New Haven,*	31 Vernon st.
Edson Keith, Jr.	*Chicago, Ill.*	200 York st.
Duane Judson Kelsey,	*Killingworth,*	29 High st.
Henry Hall Keyes,	*Stony Creek,*	25 Prospect st.
Charles Merriam Kirkham,	*Springfield, Mass.*	94 Grove st.
Albert Lucas,	*Philadelphia, Pa.*	161 York st.
William Heath Lyon, Jr.	*Brooklyn, N. Y.*	169 Temple st.
James Minor Maghee,	*Orange, N. J.*	33 Prospect st.

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Frederick Lincoln Markham,	*Tyler City,*	25 Prospect st.
Luther James Martin,	*New Haven,*	221 Elm st.
Seyton Howard Martin,	*Clifton, N. Y.*	74 High st.
George Smith Hunt McDowell,	*Portland, Me.*	489 Chapel st.
Frank Harbottle McIntosh,	*Peterboro, N. H.*	134 College st.
Henry Moorhead Montgomery,	*Portland, Oregon,*	74 High st.
George Edgar Moulthrop,	*New Haven,*	253 North Front st.
William Wallace Nichols,	*Manitou Springs, Col.*	289 York st.
Albert Anderson Noye,	*Buffalo, N. Y.*	494 Chapel st.
Herbert Lincoln Noyes,	*New Haven,*	74 High st.
Edson May Peck,	*Bristol,*	14 Lock st.
Willis LaFayette Perkins,	*Portland, Me.*	489 Chapel st.
John Thompson Perry,	*Brunswick, Me.*	44 Elm st.
Elbridge Worthington Pierce,	*Brookfield Centre,*	106 Crown st.
Louis Morgan Porter,	*Philadelphia, Pa.*	44 Elm st.
Joseph Powell, Jr.	*Towanda, Pa.*	161 Temple st.
George Simon Roberts,	*New York City,*	64 W.
Walter Allen Sadd,	*South Windsor,*	177 Temple st.
William Godfrey Sage,	*Chicago, Ill.*	175 Temple st.
Russell Sargent,	*New Haven,*	51 Elm st.
William Tuttle Shepard,	*Bristol,*	14 Lock st.
Charles Allen Stone,	*Springfield, Mass.*	523 Chapel st.
Chester Thorne,	*Millbrook, N. Y.*	65 Whitney av.
Thomas Rutherford Trowbridge, 3d,	*New Haven,*	41 College st.
James Henry Warner,	*Steubenville, O.*	Prospect st.
Elmore Abram Willets,	*Belmont, N. Y.*	44 Elm st.
Edward Simpson Wilson,	*New York City,*	134 College st.
Andrew Lincoln Winton.	*Bridgeport,*	92 Grove st.
James Prior Wood,	*West Haven.*	77 George st.
William Mason Wright,	*Newark, N. J.*	31 Temple st.

FRESHMEN, 75.

SPECIAL STUDENTS NOT CANDIDATES FOR A DEGREE.

John Edward Calhoun,	*Cornwall,*	92 Grove st.
Edward Seymour Hotchkiss,	*Bridgeport,*	67 Mansfield st.
Frederick Knowlton Mixer,	*Buffalo, N. Y.*	158 Swan st.
Warren A. Spalding,	*New Haven,*	89 Church st.
Lyman Child Wooster,	*Whitewater, Wisc.*	23 Prospect st.

SPECIAL STUDENTS, 5.

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SUMMARY.

Graduates,	19
Seniors,	34
Juniors,	55
Freshmen,	75
Special,	5
Total,	188

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SHEFFIELD SCIENTIFIC SCHOOL.

I.

OBJECTS.

THE SHEFFIELD SCIENTIFIC SCHOOL is devoted to instruction and researches in the mathematical, physical, and natural sciences, with reference to the promotion and diffusion of science, and also to the preparation of young men for such pursuits as require especial proficiency in these departments of learning. It is one of the Departments of Yale College, like the law, medical, theological, and art schools, having its separate funds, buildings, teachers, and regulations, but governed by the Corporation of Yale College, which appoints the professors and confers the degrees. It is, in part, analogous to the academic department, or classical college, and, in part, to the professional schools.

The instruction is intended for two classes of students:—

I. Graduates of this or of other Colleges, and other persons qualified for advanced or special scientific study.

II. Undergraduates who desire a training chiefly mathematical and scientific, in less part linguistic and literary, for higher scientific studies, or for various other occupations to which such training is suited.

II.

HISTORY AND ORGANIZATION.

The School was commenced in 1847. In 1860, a convenient building and a considerable endowment were given by Joseph E. Sheffield, Esq., of New Haven, whose name at the repeated request of the Corporation of Yale College, was afterward attached to the foundation. Mr. Sheffield has since frequently and munificently increased his original gifts.

In 1863, by an act of the Connecticut Legislature, the national grant for the promotion of scientific education (under the congressional enactment of July, 1862) was given to this department of Yale College. Since that time, and especially since the autumn of 1869, numerous liberal gifts have been received from the citi-

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zens of New Haven, and from other gentlemen in Connecticut, New York, and St. Louis, for the endowment of the School, and the increase of its collections.

The action of the State led to the designation by law of a State Board of Visitors, consisting of the Governor, Lieutenant-Governor, three senior Senators, and the Secretary of the State Board of Education; and this Board, with the Secretary of the Scientific School, is also the Board for the appointment of students to hold the State scholarships.

At the request of the Governing Board, the Corporation of Yale College has also appointed a Board of Councillors for the School, consisting of a number of gentlemen who have taken a deep interest in its welfare.

The Governing Board consists of the President of Yale College and the Professors who are permanently attached to the School. There are several other instructors associated with them, a part of whom are connected with other departments of the College.

III.

BUILDINGS AND APPARATUS.

The two buildings in which the work of instruction in the Scientific School is mainly carried on are called Sheffield Hall and North Sheffield Hall; but instruction in Mineralogy, Geology, and Biology, including Zoölogy and Comparative Anatomy, is now given entirely in the Peabody Museum. These halls contain a large number of recitation and lecture rooms, a hall for public assemblies and lectures, chemical and metallurgical laboratories, a photographical room, an astronomical observatory, museums, a library and reading room, besides studies for some of the professors, where their private technical libraries are kept.

The following is a summary statement of the collections belonging to the School.

1. Laboratories and Apparatus in Chemistry, Metallurgy, Physics, Photography, and Zoölogy.
2. Metallurgical Museum of Ores, Furnace Products, etc.
3. Agricultural Museum of Soils, Fertilizers, useful and injurious insects, etc.
4. Collections in Zoölogy.
5. Astronomical Observatory, with an equatorial telescope by Clark and Sons of Cambridge, a meridian circle, etc.
6. A Collection of Mechanical Apparatus, constituting the "Collier Cabinet."

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7. Models in Architecture, Geometrical Drawing, Civil Engineering, Topographical Engineering, and Mechanics; diagrams adapted to public lectures; instruments for field practice.
8. Maps and Charts, topographical, hydrographical, geological, etc.

The herbarium of Professor Brewer, and the astronomical instruments of Professor Lyman, are deposited in the buildings. Professor Eaton's herbarium, near at hand, is freely accessible. Students also have access to the various laboratories and collections in Natural Science in the Peabody Museum.

Students are also admitted, under varying conditions, to the College and Society libraries, the College Reading Room, the School of the Fine Arts, and the Gymnasium.

IV.

THE LIBRARY.

The special technical library of the Scientific School consists of about five thousand volumes. Included in this is the "Hillhouse Mathematical Library" of twenty-four hundred volumes, collected during a long series of years by Dr. William Hillhouse, and in 1870 purchased and presented to the Institution by Mr. Sheffield. A catalogue of this collection forms a supplement to the Annual Report of the Governing Board for 1870. All the prominent scientific journals of this country and of Europe, together with the proceedings of foreign academies, and of scientific societies, can be found either in this library or in the College Library to which students have access.

V.

INSTRUCTION FOR GRADUATE AND SPECIAL STUDENTS.

Persons who have gone through undergraduate courses of study, here or elsewhere, may avail themselves of the facilities of the School for more special professional training in the physical sciences and their applications, gaining in one, two, or three years the degree of BACHELOR OF PHILOSOPHY, or, in two additional years of Engineering study, that of CIVIL ENGINEER, or of DYNAMIC ENGINEER.

Or, engaging in studies of a less exclusively technical character, they may become candidates for the degree of DOCTOR OF PHILOSOPHY. The instruction in such cases will be adapted to the particular needs and capacities of each student, and may be combined

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with that given by the graduate instructors in other departments of the University. This degree is conferred upon those who, having already taken a Bachelor's degree, engage as students in the Department of Philosophy and the Arts for not less than two years in assiduous and successful study. It is not given upon examination to those whose studies are pursued elsewhere. The requirements for it will in some cases exact of the student more than two years of post-graduate labor; so, especially, wherever the course of undergraduate study has been, as in the Scientific School, of less than four years. The candidate must pass a satisfactory final examination, and present a thesis giving evidence of high attainment in the branches of knowledge to which he has attended. A good knowledge of Latin, German and French will be required in all cases, unless, for some exceptional reason, the candidate be excused by the Faculty. The graduating fee is ten dollars.

Subjects likely to receive special attention are suggested as follows:

Professor NORTON will instruct in applied mechanics and in spherical astronomy.

Professor LYMAN, in the use of meridional and other astronomical instruments.

Professor DUBOIS, in the principles of thermodynamics, and utilization of heat as a source of power.

Professor BRUSH, in the analysis and determination of mineral species, and in descriptive mineralogy.

Professor JOHNSON, in theoretical, analytical, and agricultural chemistry.

Professor BREWER, in agriculture and forest culture, in the use of the microscope, and in physical geography.

Professor CLARK, in definite integrals, differential equations, analytical mechanics, the theory of numerical approximation, and the method of least squares.

Professor EATON, in structural and systematic botany, with reference to both flowering and cryptogamous plants.

Professor ALLEN, in analytical chemistry, and in metallurgy.

Professor VERRILL, and Professor SMITH, in zoology and geology.

The same courses of study are open, for a longer or shorter time, to graduate students who do not desire to become candidates for a degree.

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Students who have taken the degree of Bachelor of Philosophy, may obtain the degree of CIVIL or of DYNAMIC ENGINEER at the end of two academical years, by pursuing the following higher course of study and professional training.

The course of study for the degree of CIVIL ENGINEER will comprise—

1. Higher Calculus. Higher Geometry. Theory of Numerical Operations.
2. Analytical Mechanics. Mechanics applied to Engineering.
3. A Course of Construction and Design. Projects.
4. Practical Astronomy, with use of instruments, computations, etc.

This course will occupy one year.

To secure the requisite amount of professional knowledge and practice, the candidate will be required to furnish a comprehensive report of the results of an examination into the existing condition of some special line of constructive art; or to present proper evidence that he has had actual charge in the field, for several months, of construction or surveying parties, or held some responsible position deemed equivalent to this.

An elaborate design must also be submitted of some projected work of construction, based upon exact data obtained from careful surveys made by the candidate, and comprising all the requisite calculations, and the necessary detailed drawings, and accompanied by full specifications of the work to be done, and the requirements to be met by the contractor.

The fee for this degree is five dollars.

The course of study for the degree of DYNAMIC ENGINEER will comprise—

1. Higher Calculus. Higher Geometry. Theory of Numerical Operations.
2. General Principles of Dynamics (Analytical Mechanics), including special application of these Principles to Dynamical problems.
3. Construction of Machines. Designs.
4. Preparation of theses on special subjects in Dynamic Engineering.

During the second year candidates will be permitted to employ such a portion of their time as may be deemed advisable or necessary in the examination of engineering works and manufacturing establishments, and may also have the privilege of entering upon professional practice, provided it is done with the knowledge and consent of the Professor of Dynamic Engineering, and under such circumstances as shall appear to him to be favorable to professional progress.

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An elaborate thesis on some professional subject, with an original design, or project, accompanied by proper working drawings, will be required at the end of the second year.

The fee for this degree is five dollars.

SPECIAL STUDENTS.—For the benefit of those who, being fully qualified, desire to pursue particular studies without reference to the obtaining of a degree, special or irregular students are received in most of the departments of the School; not, however, in the Select Course or in the Freshman Class.

It should be distinctly understood that these opportunities are not offered to persons who are incompetent to go on with regular courses, but are designed to aid those who, having received a sufficient preliminary education elsewhere, desire to increase their proficiency in special branches.

VI.

REQUIREMENTS FOR ADMISSION AND COURSES OF INSTRUCTION FOR UNDERGRADUATE STUDENTS.

TERMS OF ADMISSION.—Candidates must be not less than fifteen years of age, and must bring satisfactory testimonials of moral character from their former instructors or other responsible persons.

For admission to the Freshman Class the student must pass a thorough examination in the following subjects:

English—including grammar, spelling, and composition. In grammar, Whitney's Essentials of English Grammar, or an equivalent.

History of the United States.

Geography.

Latin—(1) Simple exercises in translating English into Latin. (Smith's "*Principia Latina*," Part I, or the First and Second Latin Books of the Ahn-Henn Latin Series (E. Steiger & Co., New York) are named as indicating the nature and extent of this requirement, and an acquaintance with one of these works will be required unless some satisfactory substitute is offered. In the last-named course one-third of each exercise may, if desired, be omitted.) (2) Cæsar—six books of the Gallic War, or their equivalent. (As advantageous substitutes for the last three books of Cæsar may be suggested three books of Vergil's Æneid, or a similar quantity of Ovid.)

Arithmetic—Fundamental Operations, Least Common Multiple, Greatest Common Divisor, Common and Decimal Fractions, Denominate Numbers, including the Metric System of Weights and Measures; Percentages, including Interest, Discount, and Commission; Proportion, Extraction of the Square and Cube Roots.

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Algebra—Fundamental Operations, Fractions, Equations of the First Degree, with one or several unknown quantities; Inequalities, Ratio and Proportion, Involution, including the Binomial Formula for an entire and positive Exponent; Evolution, the Reduction of Radicals, Equations of the Second Degree, Progressions, Permutations and Combinations, the Method of Indeterminate Coefficients, Fundamental Properties of Logarithms, Compound Interest.

Geometry—Plane, Solid, and Spherical; including fundamental notions of Symmetry, and examples of Loci and Maxima and Minima of Plane Figures.

Trigonometry—including the Analytical Theory of the Trigonometrical Functions, and the usual formulæ; the Construction and Use of Trigonometrical Tables; and the Solution of Plane Triangles;—so much, for example, as is contained in Wheeler's Plane Trigonometry (Boston, 1877), or Richards's Plane Trigonometry (New York, 1878).

While no entrance examination is held in the *History of England*, candidates for admission are urgently advised to make themselves as familiar as possible with that subject; as a knowledge of it is essential to the most successful prosecution of some of the studies of the course.

Candidates will be allowed the option of passing on the above-named subjects in two successive years. In such a case they must present themselves for examination at the June examination of the first year in the following subjects or parts of subjects: *History of the United States*, *Geography*, *Arithmetic*, *Plane Geometry*, and *Algebra to Quadratic Equations*.

In order to have this preliminary examination counted, candidates must pass satisfactorily on *all* the subjects; and notice must be given of the intention to divide the examination to Professor G. J. Brush, Executive Officer of the School, on or before June 15.

For preparation in Algebra and Geometry the recently published text-books of Professor Newcomb on these subjects (Henry Holt & Co., New York, 1881), may, without indicating undue preference, be especially recommended. And to the candidate who prepares in other works, they may serve to indicate the extent and kind of attainments expected in the prescribed topics. Candidates who prepare in the Geometry of this author, may for the present omit the short chapters on the Ellipse, Hyperbola, and Parabola; though they will find it advantageous to study them.

In his preparation in GEOMETRY the candidate should, as far as practicable, have suitable exercises in proving simple theorems and solving simple problems for himself. It is important, too, that he should be accustomed to the numerical application of geometric principles, and especially to the prompt recollection and use of the elementary formulæ of mensuration. In TRIGONOMETRY he should be exercised in applying the usual formulæ to a variety of simple reductions and transformations, including the solution of trigonometrical equations. Readiness and accuracy in trignometrical calculations are also of prime importance to the candidate. If the use of logarithms is postponed in his preparation till Trigonometry is taken up (which is by no means necessary or advisable), he should then have abundant applications of them to all forms of calculation occurring in

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ordinary practice, as well as to those appearing in the solution of triangles. Finally, in all of his calculations, he should study the art of neat and orderly arrangement.

In LATIN the student should have such continued training in parsing as shall make him thoroughly familiar with declensions and conjugations, and with the leading principles of Syntax. To secure these results more effectually, the requirement has been adopted of simple exercises in translating English into Latin. As this course of exercises is designed solely as a preparation for reading, it should be begun at the earliest stage of Latin study. A very large proportion of the deficiencies in the Latin examination for several years past has been due to the neglect of the suggestions of this paragraph, and to the attempt to read a Latin author with totally inadequate grammatical preparation.

The examinations for admission take place at North Sheffield Hall, on Thursday, Friday, and Saturday, June 29, 30, July 1, and on Tuesday and Wednesday, September 12, 13, 1882. Opportunities for private examinations may, in exceptional cases, be given at other times.

In 1882, examinations (for the Freshman Class only), will also be held in Chicago, in Cincinnati, and in San Francisco (beginning on Thursday, June 29, at 9 A. M.), at places to be announced in local newspapers of the day previous. Candidates who propose to be present are requested to send their names to Professor G. J. Brush, Executive Officer of the School, before June 15. A fee of five dollars will be charged for admission to the examinations outside of New Haven.

Candidates for advanced standing in the undergraduate classes are examined, in addition to the preparatory studies, in those already pursued by the class they wish to enter. No one can be admitted as a candidate for a degree, later than at the beginning of the Senior year.

THE COURSES OF INSTRUCTION, occupying three years, are arranged to suit the requirements of various classes of students. The first year's work is the same for all; for the last two years the instruction is chiefly arranged in special courses.

The special courses most distinctly marked out are the following:—

(*a.*) In Chemistry; (*b.*) In Civil Engineering;
(*c.*) In Dynamical (or Mechanical) Engineering;
(*d.*) In Agriculture; (*e.*) In Natural History:
(*f.*) In Biology preparatory to Medical Studies;
(*g.*) In studies preparatory to Mining and Metallurgy;
(*h.*) In Select studies preparatory to other higher studies.

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The arrangement of the studies is indicated in the annexed scheme.

FRESHMAN YEAR—INTRODUCTORY TO ALL THE COURSES:

FIRST TERM—*German*—Whitney's Grammar and Reader. *English*—Lounsbury's History of the English Language; Exercises in composition. *Mathematics*—Plane Analytical Geometry. *Physics*—Atkinson's Ganot, with experimental lectures. *Chemistry*—Recitations and Laboratory practice. *Elementary Drawing*—Practical Lessons in the Art School.

SECOND TERM—*Language, Physics, and Chemistry*—as stated above. *Mathematics*—Spherical Trigonometry (Wheeler's); Elements of Mechanics. *Physical Geography*—Lectures. *Botany*—Elementary, with Lectures. *Drawing*—Isometric Drawing, with application to drawing from models and structures by measurement. Shading and tinting. Principles of orthographic projection. Reading of working drawings and isometric construction of objects from their orthographic projections. Sections.

For the Junior and Senior years the students select for themselves one of the following courses:

(a.) IN CHEMISTRY:

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. *Qualitative Analysis*—Fresenius's. *Laboratory Practice. Blowpipe Analysis. German. French.*

SECOND TERM—*Laboratory Practice*—Qualitative Analysis, and experimental work in Organic Chemistry. *Mineralogy*—Blowpipe Analysis and determination of species. Lectures. *French. German.*

SENIOR YEAR:

FIRST TERM—*Organic Chemistry*—Lectures and Recitations. *Agricultural Chemistry*—Recitations (optional). *Laboratory Practice*—Volumetric and Mineral Analysis. *Geology*—Dana's. *Zoology*—Lectures. *French.*

SECOND TERM—*Laboratory Practice*—Analysis of Minerals and Technical Products. *Assaying* (optional). *Geology*—Dana's Manual. *Metallurgy* (optional). *Mineralogy* (optional). *French.*

(b.) IN CIVIL ENGINEERING.

JUNIOR YEAR:

FIRST TERM—*Mathematics*—Analytical Geometry of Three Dimensions; Elements of the Theory of Functions; Numerical Equations; Differential Calculus. *Surveying*—Field Operations. *Drawing*—Descriptive Geometry, begun. *German. French.*

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SECOND TERM—*Mathematics*—Integral Calculus. Rational Mechanics. *Drawing*—Descriptive Geometry, concluded. Topographical. *Surveying*—Topographical. *German. French.*

SENIOR YEAR:

FIRST TERM—*Field Engineering*—Laying out Curves. Location of Line of Railroad, with calculations of Excavation and Embankment. Hencks's Field Book for Railroad Engineers. *Civil Engineering*—Resistance of Materials. Bridges and Roofs, begun. Stone Cutting, with Graphical problems. *Geology*—Dana's. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *French.*

SECOND TERM—*Civil Engineering*—Bridges and Roofs. Building Materials. Stability of Arches and Walls. Mahan's Civil Engineering. *Dynamics*—Principles of Mechanism. Steam Engine. *Hydraulics*—Hydraulics and Hydraulic Motors. *Drawing*—Graphical Statics. *Astronomy*—Loomis's Astronomy with practical problems. *Mineralogy*—Continued. *Geology*—Dynamic. *French.*

(c.) IN DYNAMIC ENGINEERING:

JUNIOR YEAR:

FIRST TERM—*Mathematics*—Analytical Geometry of Three Dimensions; Elements of the Theory of Functions; Numerical Equations; Differential Calculus. *Surveying*—Field Practice. *Drawing*—Descriptive Geometry, begun. *German. French.*

SECOND TERM—*Mathematics*—Integral Calculus. Rational Mechanics. *Kinematics*—General Theory of Motion and Principles of Mechanism; Elementary Combinations of Pure Mechanism; Pulleys and Belts; Gearing and forms of teeth for Wheels; Parallel Motions. *Drawing*—Descriptive Geometry, concluded. *German. French.*

SENIOR YEAR:

FIRST TERM—*Statics*—Application of the Principles of Statics to Rigid Bodies; Elasticity and Strength of Materials; Forms of Uniform Strength; Stability of Structure; Construction of Roof Trusses, Girders, and Iron Bridges. *Machine Drawing*—Bolts and Nuts; Riveting; Journals, Axles, Shafts, Couplings, Pillow Blocks; Shaft-hangers, Pulleys; Connecting Rods and Cranks; Cross-Heads; Pipe connections; Valves; Steam Cylinders, Stuffing Boxes, Glands, etc. Shop Visits. *Blowpipe Analysis. French.*

SECOND TERM—*Hydrostatics and Hydrodynamics*—Equilibrium and Pressure of fluids: Hydrometers, Manometers, Gauges etc.; Water Pressure Engines and Water Wheels; Construction of Water Reservoirs and Conduits; Measurement of Water Supply; Discharge of pipes. *Thermodynamics*—General principles of Heat employed as a source of power; Theory of the Steam Engine; Hot Air Engines; Gas Engines. *Machine Designing*—Proportioning of Machine Parts, continued. Designing of Hoisting Engines; Shearing and Pumping Engines; Complete working drawings for a high speed Steam Engine. Shop Visits and Reports. *Metallurgy.*

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(d.) IN AGRICULTURE:

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry* — Lectures and Recitations. *Qualitative Analysis*—Fresenius's. *Laboratory Practice. Blowpipe Analysis. German. French.*

SECOND TERM—*Laboratory Practice* — Quantitative Analysis. *Mineralogy*—Blowpipe Analysis and Determination of Species. *Physical Geography*—Lectures. *Anatomy and Physiology*—Martin's Human Body. *Botany*—Lectures. *French. German.*

SENIOR YEAR:

FIRST TERM—*Agriculture*—Cultivation of the Staple Crops of the Northern States. Tree Planting and Forestry. *Agricultural Chemistry* — Johnson's. *Organic Chemistry* — Lectures and Recitations. *Geology*—Dana's. *Zoology. English. French.*

SECOND TERM—*Agriculture*—Laws of Heredity and Principles of Breeding; Lectures. *Geology* — Dana's. *Rural Economy* — History of Agriculture and Sketches of Husbandry in Foreign Countries; Systems of Husbandry. *Agricultural Chemistry*—Johnson's. *Geology*—Dana's. *Zoology. Botany. Microscopy. English. French.*

(e.) IN NATURAL HISTORY:

(Either Geology, Mineralogy, Zoology, or Botany, may be made the principal study, some attention in each case being directed to the other three branches of Natural History.)

JUNIOR YEAR:

FIRST TERM—*Chemistry*—Qualitative Analysis; Laboratory Practice; Recitations. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *Botany*—Gray's Manual; Laboratory Practice. *German. French.*

SECOND TERM—*Zoology*—Laboratory Practice; Recitations; Excursions (land and marine). *Botany*—Laboratory Practice; Excursions. *Anatomy and Physiology* — Martin's Human Body. *Mineralogy* — continued. *Physical Geography. German. French.*

SENIOR YEAR:

FIRST TERM—*Geology*—Dana's; Excursions. *Zoology*—Laboratory Practice; Lectures; Recitations; Excursions. *Botany*—Herbarium Studies; Gray's Textbook; Excursions. *French.*

SECOND TERM — *Geology* — Dana's. *Anatomy of Vertebrates*—Huxley's. *Zoology*—Laboratory Practice: Recitations; Lectures. *Botany*—Herbarium Studies, especially in the Cryptogamous Orders; Botanical Literature; Essays in Descriptive Botany. *Meteorology. French.*

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Besides the regular courses of recitations and lectures on structural and systematic Zoology and Botany, and on special subjects, students are taught to prepare, arrange, and identify collections, to make dissections, to pursue original investigations, and to describe genera and species in the language of science. For these purposes, large collections in Zoology and Palæontology belonging to the College are available, as are also the private botanical collections of Professor Eaton.

(f.) IN BIOLOGY—PREPARATORY TO MEDICAL STUDIES:

JUNIOR YEAR:

FIRST TERM — *Theoretical Chemistry* — Lectures and Recitations. *Qualitative Analysis*—Fresenius's; Laboratory Practice; Recitations. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *German. French.*

SECOND TERM—*Anatomy and Physiology*—Martin's Human Body. *Toxicology*—Fresenius's; Laboratory Practice; Recitations and Lectures. *Physiological Chemistry*—Sanderson's Hand-book; Recitations and Laboratory Work. *Mineralogy* — continued. *Botany* — Lectures, Practical Exercises in Phenogamous Plants, and Excursions. *German. French.*

SENIOR YEAR:

FIRST TERM—*Physiological Chemistry*—continued. *Organic Chemistry*—Lectures and Recitations. *Zoology*—Lectures. *Botany*—Practical Exercises. Lectures and Excursions. *Geology*—Dana's Manual. *French.*

SECOND TERM—*Comparative Anatomy and Histology*—Laboratory Practice and Recitations. *Geology*—Dana's Manual. *Zoology*—Lectures. *Laws of Heredity and Breeding*—Lectures. *French.*

(g.) IN STUDIES PREPARATORY TO MINING AND METALLURGY:

Young men desiring to become Mining Engineers, can pursue the regular course in Civil or Mechanical Engineering, and at its close can spend a fourth year in the study of metallurgical chemistry, mineralogy, etc.

(h.) IN THE SELECT STUDIES PREPARATORY TO OTHER HIGHER STUDIES:

JUNIOR YEAR:

FIRST TERM—*Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *Astronomy. English*—Early English. *History*—Green's Short History of the English People. *French. German.*

SECOND TERM—*Mineralogy*—Lectures. *Physical Geography*—Guyot; Lectures. *Botany*—Lectures; Excursions; Laboratory Practice. *English*—Chaucer, Bacon, Shakspere. *History*—Green's History, continued; History of the United States. *German. French.*

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SENIOR YEAR:

FIRST TERM—*Geology*—Recitations and Excursions. *Zoology*—Lectures and Excursions. *Linguistics*—Whitney's Life and Growth of Language. *English*—Shakspere. *Constitutional Law of the United States*. *French*.

SECOND TERM—*Geology*—continued. *Meteorology*—Lectures. *Political Economy*—Recitations and Lectures. *English*—Shakspere, Milton, Dryden, Pope, Gray, and later authors. *French*.

Exercises in English Composition are required during the entire course from all the students. The preparation of graduating theses is among the duties of Senior Year.

Lectures on Military Science and Tactics are annually given by General Abbot, and other officers of the Engineer Corps of the United States Army.

DRAWING.—The course in drawing extends through the three years. During the first term of Freshman year, the students practice free-hand drawing at the Art School building, under the direction of Professor Niemeyer, of the Yale School of the Fine Arts. After the completion of the course in free-hand drawing, instruction is given by Mr. F. R. Honey, during the second term in the elementary principles of instrumental drawing, embracing Elementary projection drawing, Isometric drawing, and Descriptive Geometry as far as Warped Surfaces. This course is obligatory upon all.

During the Junior and Senior years, instruction in drawing is obligatory only on the students in Civil and Mechanical Engineering. In the former year the system of instruction embraces shades and shadows, tinting, perspective, and warped surfaces. By this method all the problems in Descriptive Geometry are required to be worked out on the drawing-board instead of the black-board. The course extends through the entire year, and is under the direction of Mr. Honey.

In Senior year, students are required to apply the principles of drawing already obtained to works of construction, under the general supervision of the Professors of Civil and of Dynamic Engineering.

VII.

METHODS OF INSTRUCTION.

The instruction of this institution is given chiefly in small class rooms, in connection with recitations and by familiar lectures, illustrated by the apparatus at the command of the various

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teachers. In many studies weekly excursions are made for the purpose of collecting specimens and examining natural phenomena.

In Chemistry and Metallurgy the students work several hours daily in well-appointed laboratories, under the direct superintendence of the instructors, and are guided through systematic courses of quantitative and qualitative analysis, assaying, and the blow-pipe determination of minerals and ores.

In the course in Biology, instruction in Comparative Anatomy and Histology is given in the laboratory five or six mornings each week; the student working out for himself, by dissection and the examination of preparations, the anatomy of several types of animals, and making a large part of the microscopical preparations used in the study of the different tissues. In Physiological Chemistry the student works four hours daily in the study of the chemical processes of the body and in the preparation and examination of the more important proximate principles; thus, under the head of nutrition the various digestive processes are successively studied, artificial digestions are made, the products are separated and examined, while their physiological functions are demonstrated by experiments on animals. Special attention is also paid to the micro-chemistry of the various tissues. Students are likewise trained in qualitative and quantitative analysis of urine, both in health and in disease, not alone for the practical results to be obtained, but especially for the means which it affords of studying the metabolic changes of the body. Toxicology is taught by experiments on animals; the absorption and elimination of poisons, together with other points of physiological value, being demonstrated by chemical analysis of tissues and secretions. In each of these subjects laboratory instruction is supplemented by recitations and lectures.

In Botany, during the summer of Junior year, exercises in analyzing and identifying plants occur two or three times a week, followed by practice in writing characters and descriptions of plants from living specimens. Students are shown also the best methods of collecting and preserving for future study, specimens of Flowering Plants, Ferns, Mosses, Algæ, etc. In the autumn term of Senior year the work of the summer is continued. Students are encouraged to pursue special lines of Botanical investigation, and varied assistance is rendered them according to their needs. The final examination is intended to show what they have learned, and the collections they have made are considered to be of minor importance.

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In Zoology excursions are made during the Summer term of Junior and Fall term of Senior year, in company with the instructors, for the purpose of observing the habits and making collections of marine, fresh-water, and terrestrial animals of all classes. Each student is required to prepare and present for examination a collection containing a specified number of species, and illustrating the various classes of animals. He must also be able to pass an examination upon his collection, at least to the extent of explaining the classes and orders illustrated, and showing why particular specimens belong to the respective classes.

In Geology excursions are made for the purpose of examining geological phenomena and making special collections of rocks and minerals. Each student is required to pass a satisfactory examination on his collections at the end of the first term of Senior year.

In Civil Engineering the students, besides attending on Class recitations and lectures, pursue a systematic course of exercises in the different branches of Geometrical Drawing and Graphical Statics, and in the application of the principles of drawing to works of construction; and have good practice in the operations of Surveying and Field Engineering—acquiring facility in the use and adjustment of Surveying and Engineering Instruments. In Topographical Surveying they are instructed in the use of the Plane Table for topographical work, and are required to prepare a detailed chart of the ground surveyed—exhibiting the contour lines and all its topographical features. Numerous problems of computation, and graphical exercises, are included in the Course of Construction pursued in the Senior year. A course of Blowpipe Analysis is also taken by the Senior Class, that a more thorough knowledge may be gained of minerals and building stones.

In Dynamic Engineering the method of instruction is by recitation and lectures, supplemented by work in the drawing room, by shop visits, and visits of inspection in and out of the city, and by tests with the indicator and dynamometer. The lectures are illustrated by models, by large cartoons adapted for the purpose, and by the complete collection of working drawings of the Novelty Iron Works, owned by the School. In the drawing room, detailed working drawings of various machines are made. A general sketch of the proposed machine is given and complete detailed drawings are required, in proper shape for the pattern-maker or machinist. The student is taught the best practice, and his judgment is trained in choosing relative

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proportions. The student is required to describe the steps to be followed in building the machine, and to make as nearly as possible an estimate of its cost. Pattern, foundry, blacksmithing and machine work are studied in detail. In the visits, machinery and processes are critically examined in detail, and sketches of important machines with written descriptions are required.

In addition to the above, a course of lectures is given every winter by the professors of the schools and others, on topics of popular interest.

VIII.

TUITION CHARGES.

The charge for tuition for undergraduate students is $150 per year, payable, $55 at the beginning of the first and of the second term, and $40 at the middle of the second term. The student in the Chemical course has an additional charge of $70 per annum for chemicals and use of apparatus. He also supplies himself at his own expense with gas, flasks, crucibles, etc., the cost of which should not exceed $10 per term. A fee of $5 is charged members of the Freshman Class for chemicals and materials used in their laboratory practice, and the same fee is required from all (except Chemical students) who take the practical exercises in Blow-pipe Analysis and Determinative Mineralogy. A fee of $5 a term will also be charged to the students in the Zoological laboratory, for materials and use of instruments. An additional charge of $5 is annually made to each student for the use of the College Reading Room and Gymnasium.

For graduate students the charge for tuition is $100 per year.

IX.

CHURCH SITTINGS.

Free sittings for students in this department of Yale College are provided as follows: in the Center Church (Congr.); in the Trinity (Episc.); and in the First Methodist Church.

Those who prefer to pay for a sitting for a year, more or less, in the churches above mentioned, or in any other church of any denomination, will be aided on application to the Secretary of the School.

Sittings in the Gallery of the College Chapel are free as heretofore to the students of this department.

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X.

DEGREES.

Students of this department, on the recommendation of the Governing Board, are admitted by the Corporation of Yale College to the following degrees. They are thus conferred:

1. BACHELOR OF PHILOSOPHY: on those who complete any of the three-years courses of study, passing all the examinations in a satisfactory manner, and presenting a graduation thesis.

The fee for graduation as Bachelor of Philosophy including the fee for Triennial Catalogues, Commencement Dinners, etc., is $10; unless the person taking the degree is also an academical graduate, when it is but $5.

2. CIVIL ENGINEER and DYNAMICAL ENGINEER: The requirements for these degrees are stated on pages 28–41.

3. DOCTOR OF PHILOSOPHY: The requirements for this degree are stated on page 36.

XI.

TERMS AND VACATIONS.

The next academic year begins Thursday, September 14, 1882. The first term begins eleven weeks from Commencement-day and continues fourteen weeks: the second term begins on the second Thursday in January and continues until Commencement-day, with a Spring recess—usually of eight days—including Easter. (See Calendar, p. 2.)

XII.

ANNOUNCEMENT IN RESPECT TO STATE STUDENTS.

The scholarships established in this School in consequence of the bestowal upon it of the Congressional grants are designed to aid young men who are in need of pecuniary assistance in fitting themselves for agricultural and mechanical pursuits of life. All applicants must be citizens of Connecticut. In case there are more applicants than vacancies, candidates will be preferred who have lost a parent in the military or naval service of the United States, and next to these such as are most in need of pecuniary assistance; and the appointments will be distributed as far as practicable among the several counties in proportion to their population. The appointing Board for the current year, consist-

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; of the Board of Visitors of the State and the Secretary of
e School, will meet on June 27th, 1882, and at or about the
ne time in the year 1883, due notice of which will be given by
blication in every county of the State. All applications should
made previous to that time. Blank forms for application will
sent, when requested, by Professor GEORGE J. BRUSH, Secre-
:y of the Appointing Board.

XIII.

ANNIVERSARY.

The Anniversary of the School is held on Tuesday of the
ommencement week in Yale College, when selections from the
aduation theses are publicly read. The degrees are publicly
nferred by the President and Fellows of Yale College on Com-
encement Day.

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APPENDIX.

ENTRANCE EXAMINATION PAPERS.

The following are the papers for 1881, upon which applicants for admission were examined at the June and September examinations.

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ARITHMETIC.

JUNE, 1881.

1. Ascertain whether the fraction $\frac{2458}{61937}$ is in its lowest terms or not, and explain the process you employ.

2. (*a*) Divide $\frac{7}{257}$ by $\frac{3}{241}$ and explain the process.

(*b*) Can the quotient be exactly expressed by a terminating decimal? Give a reason for your answer.

3. Divide 0.00309824 by 0.0376, and explain the position of the decimal point in the quotient.

4. If a body revolves uniformly in the circumference of a circle at the rate of 12° 15′ 25″ per minute, how long is it in performing a complete revolution?

5. If 6 men, working uniformly at a certain rate, do a certain piece of work in 17 days of 9 hours each, how many days of $8\frac{1}{2}$ hours each will 24 men, working uniformly at the same rate, require to do 20 such pieces?

6. $5674.83 is 105 per cent. of what sum?

7. Extract the square root of 2.26 to three places of decimals. Show how you can derive from the square root of this number that of 0.0226.

8. Find the weight in grams of a rectangular bar of gold 1 decimeter long, $2\frac{1}{2}$ centimeters wide, and 2 centimeters thick, assuming the bar to be 19 times as heavy as its own volume of pure water at its maximum density.

ARITHMETIC.

SEPTEMBER, 1881.

1. Find the least common multiple of 1011, 1685 and 2359.

2. A man bought 16 horses and 19 cows for $1855. He paid upon the average $\frac{7}{15}$ as much for a cow as he did for a horse. What was the average price he paid per head for the horses?

3. Divide 0.006102 by 2.034 and explain the position of the decimal point.

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4. Reduce 18,216 ft. to miles and decimals of a mile.

5. A company whose capital is $275,000 has $15,125 from its earnings to divide. What per cent. dividend can it declare upon the basis of this sum?

6. If a block of granite 8 ft. long, 2 ft. wide and 1 ft. 6 in. thick weigh 920 lbs. how much will a block of the same kind of granite weigh which is 12 ft. long, 3 ft. wide, and 2 ft. thick.

7. Extract the cube root of 1.025 to three places of decimals.

8. (*a*) In 2.15 cubic meters how many cubic millimeters? Reduce approximately (*b*) 600 kilometers to miles, and (*c*) 50 grams to grains.

GEOMETRY.

JUNE, 1881.

NOTE 1.—Candidates for examination on the whole of this subject should take the whole of this paper. Candidates for the first year's partial examination should take the first part; those for the second year's partial examination, the second part.

NOTE 2.—State what text-book you have studied on the subject, and to what extent.

I.—PLANE GEOMETRY.

1. Of two oblique lines drawn from the same point to the same straight line, that is the greater which cuts off upon the line the greater distance from the foot of the perpendicular. Corollaries.

2. In any triangle the product of two sides is equal to the product of the diameter of the circumscribed circle by the perpendicular let fall upon the third side from the vertex of the opposite angle.

3. Two sides of a triangle and the angle opposite to one of them being given to construct the triangle.

4. The area of a circle is equal to half the product of its circumference by its radius.

5. Calculate the area of a circle whose radius is 10 ft.

II.—SOLID AND SPHERICAL GEOMETRY.

6. The sum of any two face angles of a triedral angle is greater than the third.

7. If the base of a cone is a circle, every section of the cone made by a plane parallel to the base is a circle.

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8. Calculate the area in square feet of a spherical triangle on a sphere whose radius is 10 ft., the angles of the triangle being 70°, 80°, and 120°.

9. Calculate the area of a zone on the sphere whose radius is 10 ft., the altitude of the zone being 3 ft.

10. Write expressions for the surface and volume of a cone of revolution.

GEOMETRY.

SEPTEMBER, 1881.

[State what text-book you have studied on the subject and to what extent.]

1. Through any three points not in the same straight line a circumference can be made to pass, and but one.

2. If three or more straight lines drawn through the same point intersect two parallels, the corresponding segments of the parallels are proportional.

3. To find the locus of all the points whose distances from two given points are in a given ratio.

4. Define the term *limit*. Prove that the circumference of a circle is the limit to which the perimeters of the inscribed and circumscribed regular polygons approach when the number of their sides is increased indefinitely.

5. (*a*) When is a straight line said to be perpendicular to a plane? (*b*) How do you measure the diedral-angles included between two intersecting planes?

(*c*) Prove that if a straight line is perpendicular to a plane, every plane passing through the line is also perpendicular to that plane.

6. The volume of any parallelopiped is equal to the product of its base by its altitude.

7. If two triangles on the same sphere are mutually equiangular they are also mutually equilateral; and are either equal or symmetrical.

8. The lateral area of a frustum of a cone of revolution is equal to the half sum of the circumferences of its bases multiplied by its slant height.

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ENGLISH GRAMMAR.

JUNE, 1881.

1. Mention the various classes of pronouns, and give the names of the pronouns belonging to each class.

2. How many conjugations of the verb are there, and how are they distinguished?

3. Parse the following sentence:

The friends, upon whom he had once relied, were now become his bitterest enemies; in one alone had he not been disappointed.

ALGEBRA.

JUNE, 1881.

NOTE 1.—Candidates for examination in this subject as a whole, should take the whole of this paper; those for the first year's partial examination, the first part of it; those for the second year's partial examination, the second part.

NOTE 2.—State at the head of your paper what text-book you have studied on the subject and to what extent.

I.

1. Find the greatest common divisor of
$$5a^5+10a^4b+5a^3b^2 \text{ and } a^3b+2a^2b^2+2ab^3+b^4.$$

2. Given $\frac{13m-7x}{m+p}+\frac{4m-x}{m-p}=\frac{m+p}{m-p}-kx$, to find x.

3. Two masons A and B propose to build a wall. If both work together they can finish it in 12 days; but if A work 2 days and B 3 days they will complete only one-fifth of the job. How long will it take each of them separately to do the work?

4. (*a*) Reduce $\sqrt[p]{a}$, $\sqrt[q]{b}$, $\sqrt[r]{c^3}$ to the same index.

(*b*) Simplify the following expressions:

(1.) $\sqrt[3]{8a\sqrt[3n]{a^{4-n}b}}$. (2.) $4\sqrt{48}+\sqrt{147}-4\sqrt{12}$.

(3.) $\frac{(2)^{\frac{2}{3}}(9)^{\frac{1}{6}}(3)^{\frac{1}{6}}}{(3)^{\frac{3}{5}}(4)^{\frac{1}{2}}(2)^{\frac{1}{2}}}$.

5. Given $2\sqrt{2x+2}+\sqrt{x+2}=\frac{12x+4}{\sqrt{8x+8}}$ to find x.

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II.

6. Given $4x-\frac{36-x}{x}=46$ to find x.

7. Determine by inspection the roots of the equation

$$x^2-(a+b)x+(a+c)(b-c)=0,$$

and state the principle upon which you do so.

8. Given $x^2y+xy^2=a$ and $x^2y-xy^2=b$, to find x and y.

9. Expand $(a^3+b^3)^{\frac{1}{3}}$ to four terms by the binomial formula.

10. Show that the modulus of any system of logarithms is equal to the reciprocal of the Naperian logarithm of the base of the system; and also that it is equal to the logarithm of the Naperian base taken in the system.

ALGEBRA.

September, 1881.

[State what text-book you have studied on the subject and to what extent.]

1. Resolve a^6-b^6 into four factors.

2. Given $\frac{7}{\sqrt{x}}+\frac{4}{\sqrt{y}}=4$ and $\frac{1}{\sqrt{x}}+\frac{2}{\sqrt{y}}=1$, to find x and y.

3. Simplify the following expressions:

(1.) $\frac{a^{\frac{2}{3}}}{a^{-\frac{3}{4}}}$; (2). $\left(a^{\frac{3}{4}}\right)^5$; (3). $\sqrt[4]{a^{\frac{2}{3}}}$; (4). $\sqrt[2]{\sqrt[3]{\sqrt{5ab^6}}}$;

(5). $\sqrt{\frac{2}{-2}}$; (6). $\frac{\sqrt{2}}{\sqrt[3]{2}}$.

4. Resolve the trinomial $x^2+2x-120$ into its binomial factors.

5. Given $\frac{\sqrt{3x^2-1}+\sqrt{3-x^2}}{\sqrt{3x^2-1}-\sqrt{3-x^2}}=\frac{a}{b}$ to find x.

6. Given $5x^2+2y^2=22$ and $3x^2-5y^2=7$, to find x and y.

7. A ball rolls down an inclined plane, describing one foot the first second, three feet the second, and so on. How far will it go in 10 seconds, and how far in the 10th second?

8. If the population of a certain city is now 10,000 and it increases at the annual rate of 10 per cent. for the next 10 years, what will it be at the end of that time. [Given $(1.1)^{10}=2.5937+$].

9. Expand $\frac{2+3x}{4+5x}$ into a series by the method of indeterminate coefficients.

10. Find the number of combinations of 10 things taken 4 together, and also taken 6 together.

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TRIGONOMETRY.

JUNE, 1881.

[State what text-book you have studied on the subject and to what extent.]

1. Write the values of the different trigonometric functions for angles of 0°, 90°, 180°, 270°, 300°.

2. Write the simplest equivalent expressions for

$$\sin\left(\frac{\pi}{2}-a\right),\ \cos\left(\frac{\pi}{2}+a\right),\ \tan\left(\frac{3}{2}\pi-a\right),\ \sin(2\pi-a).$$

3. Write the fundamental formulæ connecting two or more of the trigonometric functions of the same angle, and deduce any two of them.

4. Given $\tan a=\frac{m}{n}$, to find $\sin a$ and $\cos a$.

5. Deduce the formulæ

$$\cos 2a=1-2\sin^2 a;\ \sin\tfrac{1}{2}a=\sqrt{\tfrac{1}{2}(1-\cos a)}.$$

6. Prove that $\tan^{-1}\frac{1}{2}+\tan^{-1}\frac{1}{3}=\frac{\pi}{4}$.

7. In a plane triangle the side a is 4575, the side b is 5656.7 and the angle B (opposite b) is 125° 25′; find the remaining parts of the triangle.

TRIGONOMETRY.

SEPTEMBER, 1881.

[State what text-book you have studied on the subject and to what extent.]

1. Find the angle 1.8 in degrees.

2. Calculate the different functions of $\frac{\pi}{6}$ and $\frac{11}{6}\pi$.

3. Represent the different trigonometric functions of an angle in the second quadrant by lines.

4. Deduce the formula

$\cos a-\cos b=-2\sin\frac{1}{2}(a+b)\sin\frac{1}{2}(a-b)$, a and b being any angles.

5. Given $\tan\theta=\frac{m}{n}$ to find the value of $m\cos 2\theta+n\sin 2\theta$.

6. In a triangle A B C given the sides a, b, and c respectively opposite the angles A, B, and C, as follows: $a=766.3$ $b=672$ $c=565.05$ to find the angle A.

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LATIN.

JUNE, 1881.

I. Translate as literally as possible—

a. Ei legationi Ariovistus respondit: Si quid ipsi a Caesare *opus* esset, sese ad eum venturum fuisse; si quid ille se velit, illum ad se venire oportere. Praeterea se neque sine exercitu in eas partes Galliae venire audere, quas Caesar possideret, neque exercitum sine magno commeatu atque molimento in unum locum contrahere *posse.*

b. Hac re statim Caesar per speculatores cognita, insidias veritus, quod, *qua* de causa discederent, nondum perspexerat, exercitum equitatumque *castris* continuit. Prima luce, confirmata re ab exploratoribus, omnem equitatum, qui novissimum agmen moraretur, praemisit.

c. Erant ejusmodi fere situs oppidorum, ut posita in extremis lingulis promontoriisque, neque *pedibus* aditum haberent, quum ex alto *se* aestus incitavisset, quod bis accidit semper horarum viginti quattuor spatio, neque navibus, quod rursus minuente aestu naves in vadis afflictarentur.

d. Quod ubi Caesar comperit, omnibus his rebus confectis, quarum rerum causa transducere exercitum constituerat, ut *Germanis* metum injiceret, ut Sigambros ulcisceretur, ut Ubios *obsidione* liberaret, diebus omnino decem et octo trans Rhenum consumptis, satis et ad laudem et ad utilitatem profectum arbitratus, se in Galliam recepit pontemque rescidit.

e. Nostri, acriter in eos impetu facto, repulerunt, neque finem *sequendi* fecerunt, quoad *subsidio* confisi equites, quum post se legiones viderent, praecipites hostes egerunt, magnoque eorum numero interfecto, neque sui colligendi neque consistendi aut ex essedis desiliendi facultatem dederunt.

f. At in ejusmodi difficultatibus, quantum diligentia provideri poterat, providebatur, ut potius in nocendo aliquid praetermitteretur, etsi omnium animi ad *ulciscendum* ardebant, quam cum aliquo militum detrimento *noceretur.*

II. 1. Decline *situs* (12), *pedibus* (13), *vadis* (16).

2. Compare *prima* (9), *acriter* (23), *potius* (29).

3. Write the synopsis, active and passive, of *perspexerat* (8).

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4. State the mood and tense of the following: *velit* (2), *moraretur* (11), *accidit* (14), *viderent* (25), *dederunt* (27).

5. Give the principal parts of the following: *respondit* (1), *audere* (4), *contrahere* (6), *veritus* (8), *continuit* (9), *moraretur* (11), *posita* (12), *comperit* (17), *ulcisceretur* (19), *recepit* (22), *rescidit* (22), *confisi* (24).

6. State the construction of all italicized words.

7. Define indirect statement (*oratio obliqua*), and quote an example from the above text.

8. Convert into direct statement (*oratio directa*) the example quoted in answer to question seventh.

LATIN EXERCISES.

JUNE, 1881.

1. The horsemen[1] of Ariovistus hurl[2] stones[3] and[4] darts[5] at[6] the Romans.

2. Stones and darts are hurled at the Romans by the horsemen of Ariovistus.

3. It was reported[7] to Caesar (that) the horsemen of Ariovistus were hurling stones and darts at the Romans.

4. (Rewrite sentence third so as to illustrate direct statement.)

5. It was reported to Caesar (that) the horsemen of Ariovistus had hurled stones and javelins at the Romans.

6. (Rewrite sentence fifth so as to illustrate direct statement.)

7. When[8] it had been reported to Caesar, (that) the horsemen of Ariovistus were hurling stones and javelins at the Romans, he made[9] an end[10] of speaking.[11]

[1] eques.
[2] conjicere.
[3] lapis.
[4] que.
[5] telum.
[6] in.
[7] nuntiare.
[8] quum, with subjunctive.
[9] facere.
[10] finis.
[11] loqui.

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LATIN.

September, 1881.

I. Translate as literally as possible—

a. Eodem die ab exploratoribus certior factus hostes sub monte consedisse millia *passuum* ab ipsius castris octo, qualis esset natura montis et qualis in circuitu ascensus, qui cognoscerent, misit. Renuntiatum est, *facilem* esse. De tertia vigilia Titum Labienum, legatum pro praetore, cum duabus legionibus et iis ducibus, qui iter cognoverant, summum jugum montis ascendere jubet.

b. Hoc proelio facto et prope ad internecionem gente ac nomine Nerviorum redacto, majores *natu*, quos una cum pueris mulieribusque in *aestuaria* ac paludes collectos dixeramus, hac pugna nuntiata, quum victoribus nihil impeditum, victis nihil tutum arbitrarentur, omnium, qui supererant, consensu legatos ad Caesarem miserunt seque ei dediderunt.

c. Hostes undique circumventi, desperatis omnibus rebus, se per munitiones dejicere et *fuga* salutem petere intenderunt. Quos equitatus apertissimis campis consectatus, ex millium quinquaginta numero, quae ex Aquitania Cantabrisque convenisse constabat, vix quarta parte relicta, multa *nocte* se in castra recepit.

d. Reliquum exercitum Quinto Titurio Sabino et Lucio Aurunculeio Cottae, *legatis*, in Menapios atque in eos pagos Morinorum, ab quibus ad eum legati non venerant, *ducendum* dedit. Publium Sulpicium Rufum legatum, cum eo praesidio quod satis esse arbitrabatur, portum tenere jussit.

e. Equites hostium essedariique acriter *proelio* cum equitatu nostro in itinere conflixerunt, ita tamen ut nostri omnibus *partibus* superiores fuerint atque eos in silvas collesque compulerint; sed, compluribus interfectis, cupidius insecuti nonnullos ex suis amiserunt.

f. Cum his esse hospitium Ambiorigi sciebat; item per Treviros venisse *Germanis* in amicitiam cognoverat. Haec prius *illi* detrahenda auxilia existimabat, quam ipsum bello lacesseret; ne desperata salute aut se in Menapios abderet, aut cum Transrhenanis congredi cogeretur.

II. 1. Decline *millia* (2), *ducibus* (6), *jugum* (6).

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2. Compare *summum* (6), *tutum* (12), *cupidius* (28).

3. Write the synopsis, active and passive, of *misit* (4).

4. State the mood and tense of the following: *supererant* (12), *intenderunt* (15), *recepit* (19), *tenere* (24), *compulerint* (28).

5. Give the principal parts of the following: *ascendere* (7), *redacto* (9), *dediderunt* (13), *dejicere* (15), *petere* (15), *relicta* (18), *conflixerunt* (26), *compulerint* (28), *detrahenda* (32), *lacesseret* (33), *abderet* (33), *congredi* (34).

6. State the construction of all italicized words.

7. Define indirect statement (*oratio obliqua*), and quote an example from the above text.

8. Convert into direct statement (*oratio directa*) the example quoted in answer to question seventh.

LATIN EXERCISES.

September, 1881.

1. The Ubii[1] kill[2] a great[3] number[4] of the Suevi.[5]

2. A great number of the Suevi are killed by the Ubii.

3. The Ubii pursued[6] the terrified[7] Suevi.

4. The terrified Suevi were pursued by the Ubii.

5. The Ubii, having pursued the terrified Suevi, killed a great number of them.

6. It was reported[8] to Caesar (that) the Ubii had killed a great number of the Suevi.

7. (Rewrite sentence sixth so as to illustrate direct statement.)

8. It was reported to Caesar (that) the Ubii were pursuing the Suevi.

9. (Rewrite sentence eighth so as to illustrate direct statement.)

[1] Ubii.
[2] occidere.
[3] magnus.
[4] numerus.
[5] Suevi.
[6] insequi.
[7] perterritus.
[8] nuntiare.

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HISTORY OF THE UNITED STATES.

JULY, 1881.

1. When and where did the Spaniards make their first permanent settlement in North America? the English? the French?

2. State the causes and the results of the French and Indian War.

3. Arrange the following events in the order in which they occurred, with their dates: Election of John Adams, settlement of Georgia, battle of Gettysburg, introduction of slavery, assembling of the Second Continental Congress, opening of the Pacific Railroad, annexation of Texas.

4. Sketch the career of Benjamin Franklin; of Abraham Lincoln.

5. What was the Fugitive Slave law?

6. Who was President in 1803? in 1843? in 1873?

HISTORY OF THE UNITED STATES.

SEPTEMBER, 1881.

1. Sketch the settlement founded by Roger Williams; by James Oglethorpe.

2. How were the Colonies governed before the Revolution?

3. Arrange the following events in the order in which they occurred, with their dates: impeachment of Andrew Johnson, surrender of Burgoyne, introduction of the Telegraph, Lincoln's Emancipation Proclamation, battle of New Orleans, purchase of Louisiana, death of Washington.

4. Give the names of the opposing political parties in 1800; in 1868.

5. When was the Constitution adopted?

6. Sketch the administration of Monroe; Fillmore.

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GEOGRAPHY.

JULY, 1881.

1. Bound the state of Tennessee; name two cities in the state and tell how and where they are situated.

2. What states of the United States touch Lake Erie; what large cities are situated on it and in what states are they?

3. Where are the Cascade Mountains; what river or rivers break through them; name some peaks in them; in what states or territories are they?

4. What is the Torrid Zone; about how many English miles wide is it; name three cities in it and tell where they are situated.

5. Where does the River Rhine rise, what direction does it run, where does it empty, and what countries does it touch?

6. Where are the following cities: — Baltimore, Singapore, Havana, Manilla, Detroit?

GEOGRAPHY.

SEPTEMBER, 1881.

1. Bound the state of Missouri; name its largest city and tell how it is situated.

2. What states and territories of the United States touch British America or the Great Lakes through which the boundary runs—name them in their order beginning with Maine, and passing west.

3. Describe the Russian Empire, its position, its capital, its principal rivers.

4. Where does the River Oronoco rise, what is its course, where does it empty and what countries does it touch?

5. Where are the following cities:—Glasgow, Bombay, Valparaiso, Rochester, Bremen?

6. What countries surround the Mediterranean Sea, and where is each one located?

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SEVENTEENTH ANNUAL REPORT

OF THE

SHEFFIELD SCIENTIFIC SCHOOL

OF

YALE COLLEGE,

1882-83.

PRINTED BY ORDER OF THE GENERAL ASSEMBLY.

NEW HAVEN:
TUTTLE, MOREHOUSE & TAYLOR, PRINTERS.
1883.

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1883.

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STATE BOARD OF VISITORS.

CONSTITUTING, WITH THE SECRETARY OF THE SCHOOL, THE BOARD FOR THE APPOINTMENT OF STATE STUDENTS.

Governor.

HIS EXCELLENCY HOBART B. BIGELOW, New Haven.

Lieutenant-Governor.

HIS HONOR WILLIAM H. BULKELEY, Hartford.

State Senators.

HON. JOHN P. HILLS, Hartford.
HON. ROBERT COIT, New London.
HON. ANDREW S. UPSON, Farmington.

Secretary of State Board of Education.

CHARLES D. HINE.

Secretary and Treasurer of the School.

GEORGE J. BRUSH.

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REPORT

OF THE

STATE BOARD OF VISITORS.

To the General Assembly of the State of Connecticut:

In accordance with the requirements of the statutes of the State, the State Board of Visitors of the Sheffield Scientific School herewith present the Annual Report of the Governing Board of that School.

The history of this establishment of learning has been one of steady and increasing usefulness and success. It is in its purposes, and in the kind of work which it undertakes, peculiarly adapted to the wants of our State. We are preëminently an industrial community, but industrial in those departments which are based upon the most extended studies of natural science, and upon the application of the most recent results of these studies. Consequently it is here that a school devoted to the pursuit and encouragement of such studies finds its natural field. During the year just closed there has been no material change in the condition or prospects of the School. Its body of instructors has remained the same, and the number of students has somewhat increased. There is no need to call attention again to the high efficiency and devotion to their work which mark these instructors. The results as set forth in their report are their sufficient proof.

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The past year has, however, been marked by one loss, deplorable in many aspects, but especially to be regretted by the friends and managers of the Sheffield Scientific School, in the death of the founder, Joseph E. Sheffield, Esq., who died in February. Owing its existence as a well equipped establishment to the intelligent generosity of Mr. Sheffield, it has met with his encouragement, and with his liberal assistance at every stage of its growth. By his liberality Mr. Sheffield earned, not only the gratitude of those who may be trained in this school, but the permanent recognition by the State of his public spirit and far-seeing appreciation of the wants of our people. A full account of his connection with the school is found in the report. It may, we hope, be an encouragement to other generous-minded citizens of our State to continue and still more develop the work so successfully commenced.

HOBART B. BIGELOW,

Chairman.

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ANNUAL STATEMENT

OF THE

GOVERNING BOARD.

In presenting their Seventeenth Annual Report the Governing Board are again enabled to announce the increasing prosperity of the Sheffield Scientific School, so far certainly as this is indicated by the numbers in attendance. The expectation of possible growth in this way, expressed in the Report of two years ago, have been more than realized. The increase is not only a steady one, but one of its most striking peculiarities is that it is confined to no section of the country. A tabular statement has been prepared, and will be found on a subsequent page, from which it will be seen how widely scattered is the constituency from which the Scientific School draws its representatives.

In another respect the school has suffered a loss which while inevitable in the course of nature was none the less to be regretted when it came. On the 16th of February, 1882, after a short illness died the great benefactor of the school, Joseph E. Sheffield, who may be justly styled its founder. The public press has commemorated the various services of his long and honored life; and in a funeral oration delivered in the College Chapel on the evening of June 26th, during the Commencement week of 1882, the President of the University delivered a funeral oration in which he narrated the life of the most generous and disinterested benefactor which the cause of scientific education has ever known, and paid a full tribute to his many high qualities. It may be, however, proper for us to repeat briefly the story of Mr. Sheffield's connection with the school which is proud to bear his name, and to give a brief outline of the motives which induced him first to take an interest in it and of the feelings with which he came to regard it.

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The attention of Mr. Sheffield was originally directed to the Scientific School by his son-in-law, Professor John A. Porter. After the lamented death of Professor Norton in 1852, Mr. Porter, who had been professor of Chemistry in Brown University, consented to take temporary charge of the Yale Analytical Laboratory, and this ultimately led to his becoming permanently attached to the school of science which has grown out of it. From the very outset he was warmly interested in its success, and spared neither time nor labor to increase directly its efficiency and arouse the interest of others in its welfare. Beside his scientific attainments Professor Porter was a man of far more than ordinary cultivation in letters: and it was the union of these qualities rarely found in conjunction that enabled him to be of the most indispensable service to the success of the school in its feeble beginnings. To the public he became, while the state of his health allowed him to take an active part in its affairs, the leading agent in making known its needs and the leading exponent of its policy. It was his warm interest and active interposition in behalf of the school then without any endowment that led Mr. Sheffield originally to take an interest in its affairs. In 1854 the latter made a contribution of five thousand dollars, and this was the beginning of a long series of gifts which increased steadily in size as time went on. To it he added in 1856 another subscription of five thousand dollars in response to an effort that was then making to put this department of Yale College on a more satisfactory basis. About this time he acquired the property on Hillhouse avenue on which he subsequently resided, and offered that portion of it lying on the corner of Grove street, whenever money enough was raised to erect a building for the use of the Scientific School.

The effort to raise money for this purpose was unsuccessful. The institution was, in fact, in a far from satisfactory condition either as regards efficiency or permanence. A want of adequate accommodation was its most pressing need; and on being informed of this fact, by Professor Porter, Mr. Sheffield while in Europe entered into negotiations for the purchase of the building occupied by the Medical department of the college, which he purposed to give to the Scientific School. The negotiations were successful, and upon his return to this country in 1858 the whole matter was consummated. It soon became apparent, however, that additions and alterations were necessary, that a proper

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laboratory was needed, and for these objects there was no money in the hands of the Corporation of the College.

Impressed with the importance of having the building he had purchased and presented to the Corporation, thoroughly renovated and made available for the use of the school, Mr. Sheffield unsolicited addressed a note to the Trustees of Yale College, stating that he would pay for all improvements that were needed to put the building in thorough order for carrying out the objects far which it was designed. He went even further than this. No sooner was the building completed and occupied than he saw at once that this was not enough; that an endowment was needed to secure its success. He did not wait long to remedy a defect which was discovered by his own practical sagacity and not suggested by any who were interested in the welfare of this institution. To his two previous endowments of five thousand dollars he accordingly added enough to make the whole sum fifty thousand dollars, and this he directed to be employed in the part maintenance of the professorships of Engineering, Metallurgy and Chemistry. These united benefactions amounted to over one hundred thousand dollars, and constituted at the time the largest gift the college had then ever received from any one source. They came too at a critical time. They put the School at a period when scientific institutions throughout the country were in a struggling state, in a comparatively independent position; and the institution, as a consequence, entered at once upon that career of prosperity which it has since enjoyed.

It was these benefactions that led the Corporation to ask through President Woolsey that they might give to this department of the college, which he had so liberally assisted, the name of the Sheffield Scientific School. The proposition, "flattering as it was," wrote Mr. Sheffield, "I respectfully declined, for the reason (in my own mind) it might deter some of our wealthy citizens from making a much larger provision for this department fast growing in importance and in favor." After renewed requests of this sort he finally gave his consent to its being named from him, and in 1861 it received from the Corporation the title of the Sheffield Scientific School.

In 1862 Congress passed the bill appropriating to each State a certain portion of the public lands for the purpose of encouraging instruction in mechanical and agricultural science. The legislature of Connecticut authorized the income from the fund de-

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rived from this source to be given to the school of science already established here; and in order to carry out the objects of the grant still further, Mr. Sheffield, who never once lost sight of the interests of the institution, enlarged and equipped at an expense of fifty thousand dollars the building he had originally purchased and presented. Besides these, numerous other gifts for special objects were made from time to time and can be found recorded in the various reports that have been made to the legislature. His interest in the institution, indeed, kept steadily deepening to the very end of his life. Nor did he fail to maintain a watchful eye over its affairs, or to keep himself thoroughly informed as to its condition. Whenever it needed fresh facilities in consequence of its success in attracting students, he came at once to its support, not merely without solicitation but often when those entrusted with its management were unaware that he was acquainted with its necessities. A striking proof of this was seen in 1871 when he unexpectedly gave directions for the erection and equipment of a new hall, the present North Sheffield Hall. The number of students had at that time so increased that the accommodations at the command of the Governing Board were inadequate to carry on the work desired. The first notice that body had of his appreciation of the situation was a note directing the trustees to draw up estimates of a building of the character and size required.

It was about this time also that Mr. Sheffield formed the plan of having a body of trustees of his own to carry out more specifically the objects he had in view. Accordingly in February, 1871, he caused to be organized a body of nine trustees, to whom he conveyed the piece of land on which he purposed to build a hall, together with large donations of money. Three of these trustees, by the original act of incorporation, were to be permanent professors of the school; the Governor of the State, the President of Yale College, and the Chairman of the Trustees of the Peabody Museum, were *ex-officio* to belong to the board. The original board consisted in consequence of the then Governor of the State; the President of the College; Professor Dana, the Chairman of the Trustees of the Peabody Museum; John S. Beach of New Haven, William Walter Phelps of New York, and Charles J. Sheffield of Cleveland, Ohio, and the three following professors in the Scientific School: George J. Brush, Daniel C. Gilman and William P. Trowbridge. They were originally incorporated under the general act. Since that time the place of Professor Gilman has been

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taken by Professor Brewer, that of Professor Trowbridge by Professor Lounsbury. In other respects there has been no change in the board.

The various specific gifts of Mr. Sheffield can be found recorded, as has already been observed, in the Annual Reports of the preceding years, at least so far as was permitted by the unwillingness he ever manifested to have publicly known what he gave. Of this kind it is perhaps sufficient to say that for a number of years he gave directly ten thousand dollars a year for current expenses, and in the last year of his life this sum he increased to twenty thousand. The value of the gifts he has made at various times amounted at his death to about five hundred thousand dollars. By his will he put the institution on the same basis as his children, and one-seventh of the property fell in consequence to its share. It is impossible to state now what will be the precise sum that under the terms of the bequest will become the property of the Scientific School, but it is sufficiently near the truth to state that it will probably amount to half a million of dollars. It was left entirely unencumbered. Mr. Sheffield in this, as in all the contributions he made, recognized the impolicy of tying up gifts to educational institutions with conditions. The records of benevolent enterprises of all kinds will, in fact, show the name of no man who cared less than the founder of the Scientific School for what contributed to his own personal reputation. His gifts were not inspired in the slightest by the vanity of benevolence, but by a generous desire to furnish to those who were to come after the means of thorough preparation for the new duties which the new conditions of modern life demand. His whole conduct in connection with the institution was governed entirely by a disinterested zeal in behalf of higher education, which is rare even among those who have made great contributions to advance it, and by a clear-sighted judgment, often entirely unknown to men even of great cultivation, which recognized the fact that schools of learning can only be successfully managed by those who know what learning is. Friends and patrons, it is to be hoped, will come forward in the future to increase the resources and enlarge the usefulness of an institution which is still prevented from accomplishing much that is of first importance by the inadequacy of the means at its command. But its fortune will be peculiarly happy if the same generous and disinterested spirit which animated its founder, shall influence the men who are disposed to carry on the work he began.

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Renewal of the Charter.

In consequence of certain changes which had been made in codifying the laws of the State, it was thought desirable by Mr. Sheffield that instead of being organized under a general statute, a special charter should be asked for from the legislature incorporating the Board of Trustees of the Scientific School. On the motion of President Porter, therefore, at a meeting held Nov. 22, 1881, Mr. John S. Beach was requested to prepare the draft of a charter which should be presented to the legislature for their action. This was accordingly done. Before the matter could be brought before the legislature, however, Mr. Sheffield had died. It was passed in the Senate without a dissenting vote; and the House of Representatives not only passed it with the same unanimity, but on the motion of the Hon. Mr. Cleveland of Brooklyn, passed it with a rising vote. It was a tribute of respect, equally creditable to the memory of the man to whom it was paid, and to the representatives of the State who paid it.

Addition to the Corps of Permanent Professors.

The school has been fortunate during the past year in adding to the corps of its permanent officers Russell H. Chittenden as occupant of the newly-founded Chair of Physiological Chemistry. Mr. Chittenden was a graduate of the institution in the class of 1875. After graduation he remained pursuing a course of special study in Physiological Chemistry; and on account of the proficiency he displayed in this particular subject was almost immediately made instructor in it, and had the main charge of the laboratory of Physiological Chemistry until 1878. He then went to Germany and studied Chemistry and Physiology in the University of Heidelberg. Returning he again resumed charge of the Physiological Laboratory, and in 1880 received from Yale College the degree of Doctor of Philosophy. The summer of 1882 he went to Germany by request to carry on an investigation in Physiological Chemistry with Professor Kühne of Heidelberg. During his absence he was elected to the chair above-mentioned by the Corporation of Yale College at their meeting in Commencement week.

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States represented in t

In a previous part of the report atte
the large extent of country from whic
draws its students—a characteristic wh
more marked as time goes on. The follo
States from which come the students wh
catalogue during the current year, and o
bers that belong to each.

	Graduates.	Seniors.	Ju
1. California	--	--	
2. Colorado	--	1	
3. Connecticut	8	20	
4. District of Columbia,	--	--	
5. Florida	--	2	
6. Georgia	--	--	
7. Illinois	--	5	
8. Indiana	--	--	
9. Iowa	--	--	
10. Kentucky	--	--	
11. Maine	1	--	
12. Massachusetts	1	4	
13. Michigan	--	--	
14. Minnesota	--	--	
15. Missouri	--	--	
16. Nebraska	--	--	
17. New Hampshire	--	--	
18. New Jersey	--	1	
19. New York	5	7	
20. Ohio	1	2	
21. Oregon	--	--	
22. Pennsylvania	1	3	
23. South Carolina	--	1	
24. Virginia	--	--	
25. Wisconsin	--	1	
26. U. S. of Colombia	--	--	
27. Nova Scotia	1	--	
28. Turkey	1	--	
Totals,	19	47	

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Additions to the list of gifts to the Department of Dynamical Engineering S. S. S.

The Ashcroft Manufacturing Co., New York, a nickel plated "Tabor" Steam Engine Indicator, in ebony box, with extra springs and scales. A beautiful and very accurate instrument.

The Harper Steam Lubricator Co., Westville, a nickel plated drop lubricator, mounted upon steam pipe.

Henry R. Worthington & Co., New York, a Worthington Steam Pump for feeding boiler or working against heavy pressure. This pump is in complete working order, and will be particularly valuable to the students as showing a type distinct from those mentioned before.

Public Lectures.

The sixteenth annual course of lectures to mechanics and others has been given during the past year. The lecturers and their subjects are indicated in the annexed programme:

I.	Tuesday, Feb.	14.—The History of Geography.	Prof. Brewer.
II.	Thursday, "	16.—Leonardo da Vinci.	Prof. D. Cady Eaton.
III.	Tuesday, "	21.—Science and Faith.	Prof. DuBois.
IV.	Thursday, "	23.—The Building Stones of Connecticut.	Mr. H. W. Lindsley.
V.	Tuesday, "	28.—The History of Geography.	Prof. Brewer.
VI.	Thursday, Mar.	2.—Pine Trees and Pine Cones.	Prof. Daniel C. Eaton.
VII.	Tuesday, "	7.—Milk.	Dr. E. H. Jenkins.
VIII.	Thursday, "	9.—Mechanical Force, Nerve Force, Mind Force.	President Porter.
IX.	Tuesday, "	14.—Anecdotes of History.	Prof. Arthur M. Wheeler.
X.	Thursday, "	16.—What is a Contract?	Prof. Johnson T. Platt.
XI.	Tuesday, "	21.—Mammoth Cave.	Rev. H. C. Hovey.
XII.	Thursday, "	23.—Artificial Propagation and Culture of Fish.	Prof. Verrill.

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Lectures on Military Science.

A course of Lectures on Military Science, by officers of the U. S. Engineering School, at Willetts Point, was delivered in North Sheffield Hall as a part of the instruction in the School during the second term of the academic year 1881–82. The order and subjects of the Lectures were as follows:

I. Monday, Feb. 20.—Strategy and Grand Tactics.
Capt. C. W. Raymond, U. S. Engineers.
II. Friday, " 24.—Logistics. Lieut. F. V. Abbot, U. S. Engineers.
III. Monday, " 27.—Small Arms and their influence on Tactics.
Lieut. Eugene Griffin, U. S. Engineers.
IV. Friday, Mar. 3.—Artillery, Capt. J. C. Mallory, U. S. Engineers.
V. Monday, " 6.—Fortification. Capt. A. M. Miller, U. S Engineers.
VI. Friday, " 10.—Sea Coast Defence.
General H. L. Abbot, U. S. Engineers.

Additions to the Zoological Collections.

A. E. Verrill, Curator; J. H. Emerton, Assistant.

The most important additions to the Zoological collections have been due, as in several previous years, to the coöperation of the curator with the U. S. Fish Commission in the exploration of the sea-bottom, off our coasts, during the summer vacation.

The headquarters of the Commission were, last season, at Wood's Holl, Mass., as in 1881, and the work of dredging and trawling was continued from that point over an extensive region, extending about 160 miles, east and west, along the Gulf Stream slope, from 60 to 125 miles off shore, and to a depth of 780 fathoms.

This year, as in 1880 and 1881, the steamer "Fish Hawk," Lieut. Z. L. Tanner, U. S. N., commander, was employed in these expeditions. In the explorations, last season, the curator was specially assisted by Mr. Richard Rathbun, Mr. Sanderson Smith, Mr. J. H. Emerton, Professor L. A. Lee, of Bowdoin College, and by Messrs. B. F. Koons, Professor E. Linton, and H. L. Bruner, of the Sheffield Scientific School.

Miss K. J. Bush and Miss Belle Voorhees have been employed, during the year, at the expense of the U. S. Fish Commission, to

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aid the curator in assorting, arranging and cataloguing the extensive collections that have accumulated in connection with the explorations along our coast.

The extensive collections of Invertebrata, obtained during these several explorations, have been sent to our Museum to be reported upon and distributed. As fast as this can be done, good series will be deposited in the Museum. During the present year, large numbers of those that have been worked up have been labeled and sent to the National Museum, at Washington. Many of these are for their permanent collection, but large numbers are duplicates, to be made up into sets for distribution to other educational institutions.

The curator has published, during the year, several papers in the American Journal of Science, and Proc. National Museum, giving accounts of numerous new and interesting Invertebrata, dredged in the deep water off our coast, and has published in the Trans. Conn. Academy, vol. v, a "Catalogue of the marine Mollusca added to the fauna of New England during the past ten years," with five plates, and in vol. iv, a paper on New England Annelida, with ten plates. He has also prepared a report on the deep-water Anthozoa taken off our coast by Mr. A. Agassiz, on the "Blake," and by the Fish Commission, illustrated by eight plates. This is now in press.

Professor S. I. Smith has taken charge of the Crustacea in the Museum. He has published in the Bulletin of the Museum of Comparative Zoology a report on the numerous new forms of deep-water Crustacea, dredged off our coast by Mr. A. Agassiz on the "Blake," in 1880. This report is illustrated by sixteen plates. He has also prepared for publication in the Proceedings of the National Museum a lengthy illustrated paper on the deep-water Crustacea taken by the "Fish Hawk," in 1880 to 1882.

Mr. J. H. Emerton, besides making most of the drawings for the reports named above, as well as for others in progress, has published, in the Trans. Conn. Academy, vol. vi, a monograph of the New England Spiders of the family Theridiidæ, illustrated by twenty-four plates.

Mr. Emerton has nearly finished the life-sized restoration of one of the gigantic Cephalopods of Newfoundland (*Architeuthis princeps*), for the Museum, and it has been put on exhibition. He has, also, been engaged upon two duplicates of this: one for the Museum of Comparative Zoology, and one for the U. S. Fish

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Commission, to be sent to the Fishery Exhibition, at London, next spring. He has, likewise, commenced to make a model of the great *Octopus* of the California Coast.

Among the additions are the following:

University Museum, Copenhagen, Denmark, through Prof. Chr. Lütken. A collection of Annelida. In exchange.

John Allen (S. S. S.). Nest and eggs of snow-bird (*Junco hiemalis*), from the White Mountains.

T. S. Gold, West Cornwall. Large quantity of intestinal worms (*Ascaris*), from intestine of pig.

S. W. Williston. Egg of wild goose, Lake Como.

Prof. S. F. Baird, U. S. Fish Commission. Six living German carp.

A. H. Verrill, New Haven. Nest and eggs of yellow-breasted chat.

Principal J. W. Dawson, Montreal. Rare marine shells, from mouth of the St. Lawrence River. Deposited by A. E. Verrill.

C. A. Houghton, W. Medway, Mass. Mounted birds. Deposited by A. E. Verrill.

Albertus Baldwin, New Haven. "Butter-ball" duck, mounted. Purchased.

Townsend Brothers. Oysters injured by boring sponge (*Cliona sulphurea*), New Haven.

Museum of Comparative Zoology. Set of deep-water Crustacea, from the "Blake Exp.," 1880, described by Professor S. I. Smith; and of Cephalopoda, described by A. E. Verrill.

Geo. W. Potter, E. Haven. Salamander (*Amblystoma punctatum*).

Mr. and Mrs. D. A. Heald, New York, for the Memorial Collection of Charles A. Heald, class of 1881, two rare and beautiful Birds of Paradise.

F. S. Smith. Hammer-head shark.

H. S. Bruner. Two *Ozotheca odorata*, from Lake Saltonstall.

G. W. Potter, East Haven. One kitten. A monstrosity, with one head, two bodies, eight legs.

Dr. J. A. Henshall, Cynthiana, Ky. Two *Moira atropos*, Indian R. Inlet, Fla.

L. C. Wooster, (S. S. S.). Fresh-water sponge from Whitewater, Wis.

Henry E. Pardee, No. 230 Chapel st., New Haven. Specimens of wood and bark excavated by bark-beetles, from Monroe, Conn.

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Adam Herman. Turkey Buzzard killed in 1882, at Stonington, Conn. Purchased.

Rev. S. M. Hammond. Fossil shells bored by a fossil *Cliona* (sponge), from James City Co., Va., in marl pit.

Museum of Comparative Zoology. Four species of *Pentacrinus*, from deep water in the West Indies, Blake Expedition. Set of deep-sea, West Indian sponges, labeled by O. Schmidt, from the Blake Expedition.

N. J. Peck, Woodbridge. White Ermine, in the flesh, from Woodbridge, collected by Howard R. Baldwin.

Dr. Herman Friele, Bergen, Norway. Collection of rare Norwegian and Arctic shells. In exchange.

J. Gwyn Jeffreys, London. Several rare European, deep-sea shells. In exchange.

M'chse de Monterosata, Palermo. Rare deep-sea shells from near Palermo, Sicily. In exchange.

Anonymous. Ferret, killed in the street, New Haven. Purchased.

Lyman T. Hotchkiss. White Heron, killed in East Haven in 1882. Purchased.

Chas. H. Bunce, No. 169 James st., N. Haven. Several specimens of *Crematia forceps*, from New Haven.

Geo. Bray, New Haven. One albino mouse from New Haven, living.

A. L. Howard, New Haven. Lot of spiders from Umbagog Lake, Me.

Prof. G. T. Kennedy, Windsor, N. S. Sponges and shells from Bay of Fundy, Basin of Mines.

B. S. Barrows and J. A. Allen, (S. S. S.). Collection of marine invertebrata from Labrador. (Stearns Exp.)

G. E. Verrill. Mink, mounted. North Haven.

A. E. Verrill. Corals: *Caulastræa*, *Halysites*, etc. Deposited.

A. S. Packard. Two species myriapods: *Tyyopus Whitei* Ryder, Newmarket Cave, Va.; and *Scoterpes Copei* Pack., Diamond Cave, Ky.

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ANNIVERSARY.

The Exercises of the Graduating Class were held in North Sheffield Hall on the evening of Tuesday, June 27, 1882. The candidates for degrees with the subjects of the graduation theses of the Bachelors of Philosophy are given in the following schedule. Those marked with an asterisk read theses in the evening.

CIVIL ENGINEERS. (3).

FRANCIS OSCAR MAXSON, Ph.B., *Pensacola, Fla.*
WALTER WATSON, Ph.B., *Northampton, Mass.*
THOMAS WALLACE WRIGHT (A.M. Univ. Toronto), Ph.B., *Detroit, Mich.*

BACHELORS OF PHILOSOPHY. (36).

*HORACE ELLSWORTH ANDREWS (Chemistry), *Cleveland, O.* On the Salts of Tri-acetic, Tri-propionic and Tri-butyric Acids.

ALFRED WARNER ARMSTRONG (Dynamic Engineering), *Cleveland, O.* On Steam Boilers and Boiler Explosions.

CHARLES NOYES BATCHELLER (Dynamic Engineering), *Wallingford, Vt.* On the Steam Engine Indicator.

*HENRY JONATHAN BIDDLE (Select), *Philadelphia, Pa.* On the Black Hills of Dakota.

FRANCIS HAYES BLAKE (Chemistry), *New Haven.* On the Decomposition of Boronatrocalcite by Sodium Carbonate.

NATHAN GROSS BOZEMAN (Biology), *New York City.* On the Adenoid Tissue of the Cat (*Felis domesticus*).

FREDERICK CASPER (Civil Engineering), *West Meriden.* On the Hydraulic Press.

WILLIAM ANSON CHAMBERLIN (Select), *New Haven.* On Movements of Population.

WILLIAM HENRY CROCKER (Select), *San Francisco, Cal.* On the Southern Pacific Railroad.

JAMES JOHN DRUMMOND (Dynamic Engineering), *Winfield, Ill.* On Ærial Locomotion.

RICHARD LAWRENCE EVERIT (Civil Engineering), *New Haven.* On Dynamite.

*HERBERT WALDRON FAULKNER (Dynamic Engineering), *Stamford.* Design for an original Valve Gear with Mathematical Discussion.

*WILLIAM ALANSON HALL (Biology), *Morris.* On the Anatomy and Histology of the Respiratory Apparatus of the Cat (*Felis domesticus*).

ALFRED EDWARD HOOKER, B. A. (Biology), *New Haven.* On the Digestive Organs of the Black Snake (*Bascanion constrictor*).

ALEXANDER BRYAN JOHNSON (Biology), *Utica, N. Y.* On the Reproductive Organs of the English Sparrow (*Passer domesticus*).

FREDERICK WILLIAM LA FORGE (Civil Engineering), *Waterbury.* On Water Pressure Engines.

FRANK JUDSON LAMBERT (Dynamic Engineering), *New Haven.* On the Manufacture of Chilled Rolls.

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*Samuel Waldron Lambert, B.A. (Biology), *New York City.* On the Renal Organs of the Black Snake (*Bascanion constrictor*).

*Norman Smith Latham (Civil Engineering), *North Manchester.* On the Electric Railway.

*Cassius Samuel Lyman (Civil Engineering), *Holyoke, Mass.* On the Holyoke Water Power.

*Sheldon Elton Minor (Civil Engineering), *Thomaston.* Review of the Pumping Works at Whitneyville, Conn.

Edward Everett Paramore (Select), *St. Louis, Mo.* On the Railway Communications of Mexico.

*Louis Valentine Pirsson (Chemistry), *New York City.* On Crystalline Fluorides produced by Reactions in a Fused Medium.

Harry Smith Pope (Select), *Jersey City, N. J.* On Pauper Legislation.

*Robert Browning Rood (Select), *Great Barrington, Mass.* On the Mounds of the United States erected by the Mound-Builders.

Charles Edward Stockder, Jr. (Biology), *West Meriden.* On the Anatomy and Histology of the Kidney of the Cat (*Felis domesticus*).

Fred Moore Strong (Chemistry), *Boston, Mass.* On Acid Barium Propionate.

Henry Taber (Dynamic Engineering), *New York City.* On Double Algebra.

Arthur Graham Thompson (Dynamic Engineering), *Milford.* On the Manufacture of Iron Wire.

Edwin Thorne (Select), *New York City.* On Glaciers.

Thomas Pearsall Thorne (Select), *Millbrook, N. Y.* On Trotting and Trotting Horses.

Walter Jay Vought (Biology), *Buffalo, N. Y.* On the Alimentary Canal of the English Sparrow (*Passer domesticus*).

Edward Loder Whittemore (Dynamic Engineering), *Rye, N. Y.* On Malleable Cast Iron.

Alfred Buckingham Willcox (Dynamic Engineering), *Chicago, Ill.* On the Westinghouse Compressed Air Brake.

Chauncey Pratt Williams, Jr. (Select), *Albany, N. Y.* On the National Banking System of the United States.

Samuel Lawrence Williams (Select), *Chicago, Ill.* On the Factory Laws of England and America.

Prizes.

At the Anniversary Exercises on June 27th the following prizes were announced:

CLASS OF 1882.

For excellence in Civil Engineering, Norman Smith Latham, and Sheldon Elton Minor.

For excellence in Dynamic Engineering, Frank Judson Lambert, and Herbert Waldron Faulkner.

For excellence in German, Frederick William LaForge.

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CLASS OF 1883.

For excellence in the Mathematics of Junior Year, JOHN BAR
FREDERICK ELIJAH BEACH.

CLASS OF 1884.

For excellence in all the Studies of Freshman Year, CHARLES PERCI
and EDWIN MUSSER HERR, with honorable mention of GE
CUMMINS.

For excellence in German, CHARLES PERCIVAL FARQUHAR.

For excellence in Mathematics, CHARLES PERCIVAL FARQUHAR.

For excellence in Physics, EDWARD BLAKE, CHARLES PERCIVAL
EDWIN MUSSER HERR.

For excellence in Chemistry, EDWIN MUSSER HERR.

For excellence in Mechanical Drawing, GEORGE WYCKOFF CU
MUSSER HERR, HARRY HALL KEYES, and ALBERT LUCAS.

For excellence in English Composition, 1st Prizes, DAVENPORT GALI
LINSLEY HARRISON, SAMUEL BROWN HAWLEY, EDWIN MUS
WILLIAM WALLACE NICHOLS; 2d Prizes, LAWRENCE VINCE
JAMES HENRY WARNER; 3d Prizes, BENJAMIN WALES D
PERCIVAL FARQUHAR, and WILLIS LAFAYETTE PERKINS.

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PROGRAMME OF STUDIES,

AND

CATALOGUE,

FOR THE COLLEGE YEAR 1882-83.

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CALENDAR.

1882.		
14 Sept.	Thursday,	First Term begins.
21 Dec.	Thursday,	First Term ends.
1883.		**Winter Vacation of three weeks.**
11 Jan.	Thursday,	Second Term begins.
21 March,	Wednesday,	Spring Recess begins.
28 March,	Wednesday,	Spring Recess ends.
26 June,	Tuesday,	Meeting of Appointing Board.
26 June,	Tuesday,	Anniversary.
27 June,	Wednesday,	Commencement.
28, 29, 30 June	Thursday, Friday, Sat.,	Examination for Admission.
		Summer Vacation of eleven weeks.
11, 12 Sept.	Tues., Wedn.,	Examination for Admission.
13 Sept.	Thursday,	First Term begins.
20 Dec.	Thursday,	First Term ends.

ABBREVIATIONS.

S. H.	Sheffield Hall.
N. S. H.	North Sheffield Hall.
TR.	Treasury Building.
D.	Durfee College.
F.	Farnam College.
E.	East Divinity Hall.
W.	West Divinity Hall.
P. M.	Peabody Museum.
A.	Absent on leave.

In the buildings belonging to the Sheffield Scientific School, the rooms numbered from 1 to 21 are in Sheffield Hall; from 26 to 58 in North Sheffield Hall.

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CORPORATION.

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REV. NOAH PORTER, D.D., LL.D.

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HENRY C. KINGSLEY, M.A. (5 TR.) 23 Hi

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ARRANGED IN THE ORDER OF THEIR GRADUATION.

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JOHN E. CLARK,
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OSCAR D. ALLEN,
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Chemistry. (8 S. H.) 8 Trumbull st.

A. JAY DUBOIS,
Dynamical Engineering (HIGGIN *Professor*). (45 N. S. H.) 328 Howard av.

HENRY W. FARNAM,
Political Economy and History. 43 Hillhouse av.

RUSSELL H. CHITTENDEN,
Physiological Chemistry. (12 S. H.) 107 York st.

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Analytical Chemistry. 138 College st.

CHARLES HILDEBRAND,
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LOUIS V. PIRSSON,
Analytical Chemistry. 53 Prospect st.

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ANTON PFEIFER, 55 Lock street.

JANITOR OF NORTH SHEFFIELD HALL.

GEORGE W. STODDARD, 82 Mansfield street.

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GRADUATE STUDENTS.

Frank Frost Abbott, B.A.	*Redding*	158 York st.
Henry Jonathan Biddle, PH.B.	*Philadelphia, Pa.*	128 High st.
Frederick Casper, PH.B.	*West Meriden*	West Meriden
Edward Holyoke Farrington, B.S. State College, Me.	*Portland, Me.*	14 Lock st.
Herbert Waldron Faulkner, PH.B.	*Stamford*	53 Prospect st.
Frank Albert Kellogg, B.A.	*New Haven*	167 George st.
George Thomas Kennedy, M.A. McGill College	*Windsor, N. S.*	59 Prospect st.
Sarkis Levonian, Central Turkey College	*Aintab, Turkey*	67 Mansfield st.
Ernest Theophilus Liefeld, PH.B.	*New Haven*	36 Orchard st.
Wilber McBride, B.A.	*Goshen, N. Y.*	116 College st.
Marcus Daty Munn, PH.B.	*Southington*	16 S. H.
Harold Bayless Nye, B.A. Marietta College	*Marietta, O.*	91 W.
Samuel Lucius Penfield, PH.B.	*Catskill, N. Y.*	14 S. H.
Thomas Burr Osborne, B.A.	*New Haven*	156 Crown st.
Louis Valentine Pirsson, PH.B.	*New York City*	53 Prospect st.
Charles Locke Scudder, B.A.	*Great Barrington, Mass.*	4 Library st.
Edward Vernon Silver, B.A.	*Brooklyn, N. Y.*	523 Chapel st.
Elliott Joseph Stoddard, LL.B. Columbia College	*New Haven*	157 Church st.
Franklin Eldred Worcester, B.A.	*Albany, N. Y.*	60 W.

GRADUATE STUDENTS, 19.

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SENIOR CLASS.

Paul Whitin Abbott	*New Haven*	257 Church st.
John Alpheus Allen	*New Haven*	197 Temple st.
Benjamin Safford Barrows	*Hartford*	163 Temple st.
George Andrew Barrows	*Philadelphia, Pa.*	43 College st.
John Bartholomew	*Guilford*	17 Wooster pl.
Frederic Robinson Bartlett	*Freeport, Ill.*	36 Elm st.
Frederick Elijah Beach	*New Haven*	44 Lyon st.
Frederick Truman Bradley	*New Haven*	142 Orange st.
Charles Parker Breese	*Meriden*	489 Chapel st.
Charles Sumner Brown	*East Hampton*	61 Prospect st.
Charles Milo Carpenter	*Madison, Wisc.*	36 Elm st.
Horace Raymond Carpenter	*Afton, N. Y.*	60 w.
Samuel Myron Chase	*Chicago, Ill.*	109 York st.
Harry Nelson Covell	*Stamford*	43 College st.
Wayne Darlington	*West Chester, Pa.*	55 Trumbull st.
Edward Bradford Dench	*Bridgeport*	67 Mansfield st.
Henry Kelsey Devereux	*Cleveland, O.*	43 College st.
Robert Ogden DuBois	*New Haven*	328 Howard av.
Edward Peers Eastwick, Jr.	*New York City*	36 Elm st.
Horatio Southworth Frazer	*Holyoke, Mass.*	77 w.
Charles Lockwood Gold	*West Cornwall*	49 Grove st.
Charles Stewart Hall	*Warren, O.*	36 Elm st.
George Vance Harper	*Denver, Col.*	41 Trumbull st.
William Harper	*Shippensburg, Pa.*	163 Temple st.
Allen Hubbard	*Westfield, Mass.*	61 Prospect st.
John Elmer Lockwood	*Stamford*	146 Dixwell av.
William Ellison Lockwood	*Stamford*	146 Dixwell av
James Lyman	*Middlefield*	109 Wall st.
John Edmund Newell	*Chicago, Ill.*	88 w.
Henry Curtis Nutt, Jr.	*Boston, Mass.*	36 Elm st.
George Shipman Payson	*Chicago, Ill.*	76 w.
Edward Wells Penfield	*Chicago, Ill.*	109 Elm st.
James Edward Pope, Jr.	*Jersey City, N. J.*	61 w.
David Murdoch Pratt	*Elmira, N. Y.*	36 Elm st.
Willie Sherman Randall	*Birmingham*	159 Temple st.
Albert William Robert	*New York City*	36 Elm st.
Joseph Warren Rogers, Jr.	*Scarborough, N. Y.*	137 College st.
Charles Lansing Sayre	*Utica, N. Y.*	43 College st.
Horace Lee Simpson	*Pensacola, Fla.*	146 College st.
Ebenezer Hubbard Skinner	*Escambia, Fla.*	146 College st.
Joseph Allen Skinner	*Holyoke, Mass.*	109 Elm st.
Edward Irving Stone	*Bethlehem*	159 Temple st.
John Edwards Stryker	*Catskill, N. Y.*	77 w.
Chuan Lok Wing	*China*	167 Temple st.
Alonzo Felton Wood, Jr.	*West Haven*	77 George st.
Alexander Wurts	*New Haven*	65 Whitney av.
Robert Hawthorne Wylie	*Chester, S. C.*	55 Trumbull st.

SENIORS, 47.

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JUNIOR CLASS.

Gustavo Alfonso	*New York City*	36 Elm st.
Elwood Harvey Allcutt	*Kansas City, Mo.*	55 Trumbull st.
Theodore Davenport Bacon	*Norwich*	53 Prospect st.
Lawrence Vincent Benét	*Washington, D. C.*	106 w.
Edward Blake	*New Haven*	149 Temple st.
Charles Francis Bosworth	*Milford*	387 York st.
Clarence Russell Britton	*Cleveland, O.*	36 Elm st.
Chauncey Rea Burr	*Portland, Me.*	63 Prospect st.
Albert Park Campbell	*New Haven*	16 York sq.
Herbert DeWitt Carrington	*New Haven*	527 Chapel st.
James Edward Carter	*New Haven*	121 Elm st.
William Brainard Coit	*New London*	36 Elm st.
Clifford Lawrence Colton	*Canton*	215 York st.
Louis Edward Cooper	*Ansonia*	347 York st.
George Wyckoff Cummins	*Vienna, N. J.*	347 York st.
Charles Percival Farquhar	*York, Pa.*	289 York st.
Arthur Bixby Ferguson	*New Haven*	30 Crown st.
Davenport Galbraith	*Erie, Pa.*	36 Elm st.
Morgan Augustus Guinnip	*Elmira, N. Y.*	136 Crown st.
Pelham Hague	*Tidioute, Pa.*	285 York st.
Calvin Linsley Harrison	*New Haven*	94 Wooster st.
John Bell Hatcher	*Cooper, Iowa*	12 Elm st.
Samuel Brown Hawley	*Yonkers, N. Y.*	43 College st.
Edwin Musser Herr	*Denver, Col.*	289 York st.
James Henry Jennings	*Redding*	215 York st.
Thomas Crossley Johnson	*New Haven*	80 LaFayette st.
Edson Keith, Jr.	*Chicago, Ill.*	200 York st.
Duane Judson Kelsey	*Killingworth*	29 High st.
Henry Hall Keyes	*Stony Creek*	276 Elm st.
Albert Lucas	*Philadelphia, Pa.*	43 College st.
William Heath Lyon, Jr.	*Brooklyn, N. Y.*	76 w.
James Minor Maghee	*Evansville, Ind.*	63 Prospect st.
Luther James Martin	*Norwich*	361 Elm st.
Seyton Howard Martin	*Clifton, N. Y.*	85 w.
George Edgar Moulthrop	*New Haven*	253 North Front st.
William Wallace Nichols	*Manitou Springs, Col.*	289 York st.
Albert Anderson Noye	*Buffalo, N. Y.*	99 Wall st.
Herbert Lincoln Noyes	*New Haven*	74 High st.
Joseph Powell, Jr.	*Towanda, Pa.*	43 College st.
George Simon Roberts	*New York City*	101 w.
Walter Allen Sadd	*South Windsor*	159 Temple st.
William Godfrey Sage	*Chicago, Ill.*	63 Prospect st.
Russell Sargent	*New Haven*	51 Elm st.
Clarence Wellington Sheldon	*Brooklyn, N. Y.*	133 College st.
William Tuttle Shepard	*Bristol*	215 York st.

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John Prentice Terry	*Brooklyn, N. Y.*	157 Orange st.
Chester Thorne	*Millbrook, N. Y.*	55 Trumbull st.
Thomas Rutherford Trowbridge, 3d	*New Haven*	41 College st.
James Henry Warner	*Steubenville, O.*	Prospect st.
Elmore Abram Willets	*Belmont, N. Y.*	44 Elm st.
Edward Simpson Wilson	*New York City*	101 W.
Andrew Lincoln Winton	*Bridgeport*	63 Prospect st.

JUNIORS, 52.

FRESHMAN CLASS.

Arthur Bronson Adams	*New Haven*	120 St. John st.
Grenville French Allen	*New Haven*	197 Temple st.
Philip VanWyck Anderson	*Sing Sing, N. Y.*	82 Wall st.
James Arthur Atwood	*Wauregan*	167 Temple st.
John Walter Atwood	*Wauregan*	167 Temple st.
John Frank Babcock	*Elmira, N. Y.*	31 Temple st.
Rodney Fisher Bates	*New York City*	103 Wall st.
Paul Daily Bernard	*Brooklyn, N. Y.*	133 College st.
Clarence Blakeslee	*New Haven*	316 George st.
Robert Neill Brace	*Dobbs Ferry, N. Y.*	165 Temple st.
George Tyler Brown	*Yonkers, N. Y.*	31 Temple st.
Fred Spencer Bullene	*Kansas City, Mo.*	44 Elm st.
Richard Morton Bushnell, Jr.	*Saybrook*	17 Wooster pl.
Merritt Mead Clark	*Bedford, N. Y.*	177 Temple st.
Wallace Sherman Clark	*Norfolk, Va.*	226 George st.
Arthur Chandler Coates	*Kansas City, Mo.*	40 Elm st.
Arthur Carrington Cowles	*Wallingford*	136 College st.
William Ledlie Culbert	*Brooklyn, N. Y.*	134 College st.
Hammond Jeremiah Dutton	*Hillsboro Bridge, N. H.*	109 High st.
Martin Juan Echeverria	*Panama, Colombia*	17 Wooster pl.
John Joseph Flather	*Bridgeport*	67 Mansfield st.
William Holt Gale	*New York City*	109 Elm st.
Harry Brainard Gaylord	*New Haven*	40 Academy st.
Irving Cook Gladwin	*Sherburne, N. Y.*	74 High st.
James Richard Godman	*La Fayette, Ind.*	31 Temple st.
Jacob Phillip Goodhart	*New Haven*	107 Court st.
Charles Lord Griffith	*San Francisco, Cal.*	489 Chapel st.
John Venable Hanna	*Kansas City, Mo.*	165 Temple st.
James H. Hepburn	*Jersey Shore, Pa.*	103 Wall st.
John Ethan Hill	*Mystic Bridge*	295 York st.
David Leavitt Hough	*Fort Wayne, Ind.*	111 York st.

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Marvin D. Hubbell	*New York City*	94 York sq.
Percy Jackson	*Belleville, N. J.*	109 York st.
Edwin Young Judd	*Hartford*	7 Library st.
Amos William Kimball	*Portland, Oregon*	161 Temple st.
Charles Merriam Kirkham	*Springfield, Mass.*	94 Grove st.
Harry D. Kohn	*Chicago, Ill.*	696 State st.
Ira Lamb	*Franklin*	157 Orange st.
Percy Lyford Lang	*Elmira, N. Y.*	161 Temple st.
Charles Pond McAvoy	*Chicago, Ill.*	242 York st.
Charles Dickerman McCandliss	*Philadelphia, Pa.*	119 College st.
William Adair McDowell	*Woodlake, Ky.*	203 York st.
Daniel William Maher	*New Haven*	305 Howard av.
Daniel Delevan Mangam, Jr.	*Sing Sing, N. Y.*	44 Elm st.
William Edward Martin	*Allentown, Pa.*	167 Temple st.
Edwin Alexander Meredith	*Xenia, O.*	55 Prospect st.
Deane Miller	*New Rochelle, N. Y.*	226 George st.
Herbert Lincoln Mitchell	*New Haven*	121 Park st.
Henry Moorhead Montgomery	*Portland, Oregon*	36 Elm st.
James Jacob Morgan	*New Haven*	470 Elm st.
William Alpheus Nettleton	*Kansas City, Mo.*	44 Elm st.
Truman Handy Newberry	*Detroit, Mich.*	464 Chapel st.
Herbert Beecher Nichols	*Yonkers, N. Y.*	31 Temple st.
Isaac Norris, 3d	*Philadelphia, Pa.*	74 High st.
George Washington Norton, Jr.	*Louisville, Ky.*	237 Orange st.
Henry Oliver	*Pittsburgh, Pa.*	31 Trumbull st.
John Cunningham Oliver	*Pittsburgh, Pa.*	31 Trumbull st.
Abbott Chandler Page	*Fair Haven*	South Quinnipiac st.
Willis LaFayette Perkins	*Portland, Me.*	489 Temple st.
Royal Watson Pinney	*Derby*	167 Temple st.
Daniel Tuthill Pratt	*Elmira, N. Y.*	31 Temple st.
Sidney Armour Reeve	*Dayton, O.*	61 Grove st.
Willard Crawford Reid	*Lakeville*	74 High st.
John Rice	*Pottstown, Pa.*	489 Chapel st.
Charles Thomas Richardson	*Hornellsville, N. Y.*	44 Elm st.
William Todd Ross	*Belfast, Me.*	53 Prospect st.
Charles Gideon Rupert	*New Market, Va.*	111 Dwight st.
Frank Elbert Sands	*New Haven*	119 Dwight st.
Louis Milton Schmidt	*New Britain*	59 Grove st.
James Alward Seymour	*Auburn, N. Y.*	44 Elm st.
Murray Shipley, Jr.	*Cincinnati, O.*	109 Elm st.
Joseph Godfrey Snydacker	*Chicago, Ill.*	696 State st.
Frank Jerome Stevens	*New Haven*	7 Wooster pl.
William VanSchoonhoven Thorne	*New York City*	65 Whitney av.
Henry Lee Townsend	*New York City*	82 Wall st.
Curtiss Chauncey Turner	*Omaha, Nebr.*	156 Grove st.
George Elliot Verrill	*New Haven*	148 College st.
Frederick Brewster Wheeler	*Monroe*	175 Temple st.
Henry Howard Whitehouse	*Hartford*	167 Temple st.

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Willis Stoughton Williams	*Minneapolis, Minn.*	121 Park st.
Winslow Tracy Williams	*Norwich*	134 College st.
Clarence Henry Wood	*Morristown, N. J.*	120 York st.
Benjamin Elizur Wright	*Cromwell*	165 Temple st.

FRESHMEN, 83.

SPECIAL STUDENTS NOT CANDIDATES FOR A DEGREE.

George Barclay Bassett	*Watertown, N. Y.*	4 Mansfield st.
John Edward Calhoun	*Cornwall*	450 Chapel st.
Edward Seymour Hotchkiss	*Bridgeport*	Bridgeport
Henry Clay Johnson	*Rome, Ga.*	41 High st.
Warren A. Spalding	*New Haven*	89 Church st.
James Prior Wood	*West Haven*	2 Church st.

SPECIAL STUDENTS, 6.

SUMMARY.

GRADUATES,	19
SENIORS,	47
JUNIORS,	52
FRESHMEN,	83
SPECIAL,	6
TOTAL,	207

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SHEFFIELD SCIENTIFIC SCHOOL.

I.

OBJECTS.

The Sheffield Scientific School is devoted to instruction and researches in the mathematical, physical, and natural sciences, with reference to the promotion and diffusion of science, and also to the preparation of young men for such pursuits as require especial proficiency in these departments of learning. It is one of the Departments of Yale College, like the law, medical, theological, and art schools, having its separate funds, buildings, teachers, and regulations, but governed by the Corporation of Yale College, which appoints the professors and confers the degrees. It is, in part, analogous to the academic department, or classical college, and, in part, to the professional schools.

The instruction is intended for two classes of students:—

I. Graduates of this or of other Colleges, and other persons qualified for advanced or special scientific study.

II. Undergraduates who desire a training chiefly mathematical and scientific, in less part linguistic and literary, for higher scientific studies, or for various other occupations to which such training is suited.

II.

HISTORY AND ORGANIZATION.

The School was commenced in 1847. In 1860, a convenient building and a considerable endowment were given by Joseph E. Sheffield, Esq., of New Haven, whose name at the repeated request of the Corporation of Yale College, was afterward attached to the foundation. Mr. Sheffield has since frequently and munificently increased his original gifts.

In 1863, by an act of the Connecticut Legislature, the national

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grant for the promotion of scientific education (under the congressional enactment of July, 1862) was given to this department of Yale College. Since that time, and especially since the autumn of 1869, numerous liberal gifts have been received from the citizens of New Haven, and from other gentlemen in Connecticut, New York, and St. Louis, for the endowment of the School, and the increase of its collections.

The action of the State led to the designation by law of a State Board of Visitors, consisting of the Governor, Lieutenant-Governor, three senior Senators, and the Secretary of the State Board of Education: and this Board, with the Secretary of the Scientific School, is also the Board for the appointment of students to hold the State scholarships.

The Governing Board consists of the President of Yale College and the Professors who are permanently attached to the School. There are several other instructors associated with them, a part of whom are connected with other departments of the College.

III.

BUILDINGS AND APPARATUS.

The two buildings in which the work of instruction in the Scientific School is mainly carried on are called Sheffield Hall and North Sheffield Hall; but instruction in Mineralogy, Geology, and Biology, including Zoölogy and Comparative Anatomy, is now given entirely in the Peabody Museum. These halls contain a large number of recitation and lecture rooms, a hall for public assemblies and lectures, chemical and metallurgical laboratories, a photographical room, an astronomical observatory, museums, a library and reading room, besides studies for some of the professors, where their private technical libraries are kept.

The following is a summary statement of the collections belonging to the School.

1. Laboratories and Apparatus in Chemistry, Metallurgy, Physics, Photography, and Zoölogy.
2. Metallurgical Museum of Ores, Furnace Products, etc.
3. Agricultural Museum of Soils, Fertilizers, useful and injurious insects, etc.
4. Collections in Zoölogy.
5. Astronomical Observatory, with an equatorial telescope by Clark and Sons of Cambridge, a meridian circle, etc.
6. A Collection of Mechanical Apparatus, constituting the "Collier Cabinet."

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7. Models in Architecture, Geometrical Drawing, Civil Engineering, Topographical Engineering, and Mechanics; diagrams adapted to public lectures; instruments for field practice.
8. Maps and Charts, topographical. hydrographical, geological, etc.

The herbarium of Professor Brewer, and the astronomical instruments of Professor Lyman, are deposited in the buildings. Professor Eaton's herbarium, near at hand, is freely accessible. Students also have access to the various laboratories and collections in Natural Science in the Peabody Museum.

Students are also admitted, under varying conditions, to the College and Society libraries, the College Reading Room, the School of the Fine Arts, and the Gymnasium.

IV.

THE LIBRARY.

The special technical library of the Scientific School consists of about five thousand volumes. Included in this is the "Hillhouse Mathematical Library" of twenty-four hundred volumes, collected during a long series of years by Dr. William Hillhouse, and in 1870 purchased and presented to the Institution by Mr. Sheffield. A catalogue of this collection forms a supplement to the Annual Report of the Governing Board for 1870. All the prominent scientific journals of this country and of Europe, together with the proceedings of foreign academies, and of scientific societies, can be found either in this library or in the College Library to which students have access.

V.

INSTRUCTION FOR GRADUATE AND SPECIAL STUDENTS.

Persons who have gone through undergraduate courses of study, here or elsewhere, may avail themselves of the facilities of the School for more special professional training in the physical sciences and their applications, gaining in one, two, or three years the degree of Bachelor of Philosophy, or, in two additional years of Engineering study, that of Civil Engineer, or of Dynamic Engineer.

Or, engaging in studies of a less exclusively technical character, they may become candidates for the degree of Doctor of Philosophy. The instruction in such cases will be adapted to the particular needs and capacities of each student, and may be combined

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with that given by the graduate instructors in other departments of the University. This degree is conferred upon those who, having already taken a Bachelor's degree, engage as students in the Department of Philosophy and the Arts for not less than two years in assiduous and successful study. It is not given upon examination to those whose studies are pursued elsewhere. The requirements for it will in some cases exact of the student more than two years of post-graduate labor; so, especially, wherever the course of undergraduate study has been, as in the Scientific School, of less than four years. The candidate must pass a satisfactory final examination, and present a thesis giving evidence of high attainment in the branches of knowledge to which he has attended. A good knowledge of Latin, German and French will be required in all cases, unless, for some exceptional reason, the candidate be excused by the Faculty. The graduating fee is ten dollars.

Subjects likely to receive special attention are suggested as follows:

Professor NORTON will instruct in applied mechanics and in spherical astronomy.

Professor LYMAN, in the use of meridional and other astronomical instruments.

Professor DUBOIS, in the principles of thermodynamics, and utilization of heat as a source of power.

Professor BRUSH, in the analysis and determination of mineral species, and in descriptive mineralogy.

Professor JOHNSON, in theoretical, analytical, and agricultural chemistry.

Professor BREWER, in agriculture and forest culture, in the use of the microscope, and in physical geography.

Professor CLARK, in definite integrals, differential equations, analytical mechanics, the theory of numerical approximation, with the method of least squares.

Professor EATON, in structural and systematic botany, with reference to both flowering and cryptogamous plants.

Professor ALLEN, in analytical chemistry, and in metallurgy.

Professor VERRILL, and Professor SMITH, in zoology and geology.

The same courses of study are open, for a longer or shorter time, to graduate students who do not desire to become candidates for a degree.

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Students who have taken the degree of Bachelor of Philosophy, may obtain the degree of CIVIL or of DYNAMIC ENGINEER at the end of two academical years, by pursuing the following higher course of study and professional training.

The course of study for the degree of CIVIL ENGINEER will comprise—

1. Higher Calculus. Higher Geometry. Theory of Numerical Operations.
2. Analytical Mechanics. Mechanics applied to Engineering.
3. A Course of Construction and Design. Projects.
4. Practical Astronomy, with use of instruments, computations, etc.

This course will occupy one year.

To secure the requisite amount of professional knowledge and practice, the candidate will be required to furnish a comprehensive report of the results of an examination into the existing condition of some special line of constructive art; or to present proper evidence that he has had actual charge in the field, for several months, of construction or surveying parties, or held some responsible position deemed equivalent to this.

An elaborate design must also be submitted of some projected work of construction, based upon exact data obtained from careful surveys made by the candidate, and comprising all the requisite calculations, and the necessary detailed drawings, and accompanied by full specifications of the work to be done, and the requirements to be met by the contractor.

The fee for this degree is five dollars.

The course of study for the degree of DYNAMIC ENGINEER will comprise—

1. Higher Calculus. Higher Geometry. Theory of Numerical Operations.
2. General Principles of Dynamics (Analytical Mechanics), including special application of these Principles to Dynamic problems.
3. Construction of Machines. Designs.
4. Preparation of theses on special subjects in Dynamic Engineering.

During the second year candidates will be permitted to employ such a portion of their time as may be deemed advisable or necessary in the examination of engineering works and manufacturing establishments, and may also have the privilege of entering upon professional practice, provided it is done with the knowledge and consent of the Professor of Dynamic Engineering, and under such circumstances as shall appear to him to be favorable to professional progress.

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An elaborate thesis on some professional subject, with an original design, or project, accompanied by proper working drawings, will be required at the end of the second year.

The fee for this degree is five dollars.

SPECIAL STUDENTS.—For the benefit of those who, being fully qualified, desire to pursue particular studies without reference to the obtaining of a degree, special or irregular students are received in most of the departments of the School: not, however, in the Select Course or in the Freshman Class.

It should be distinctly understood that these opportunities are not offered to persons who are incompetent to go on with regular courses, but are designed to aid those who, having received a sufficient preliminary education elsewhere, desire to increase their proficiency in special branches.

VI.

REQUIREMENTS FOR ADMISSION AND COURSES OF INSTRUCTION FOR UNDERGRADUATE STUDENTS.

TERMS OF ADMISSION.—Candidates must be not less than fifteen years of age, and must bring satisfactory testimonials of moral character from their former instructors or other responsible persons.

For admission to the Freshman Class the student must pass a thorough examination in the following subjects:

English—including grammar, spelling, and composition. In grammar, Whitney's Essentials of English Grammar, or an equivalent.

History of the United States.

Geography.

Latin—(1) Simple exercises in translating English into Latin. (Smith's "*Principia Latina*," Part I, or the First and Second Latin Books of the Ahn-Henn Latin Series (E. Steiger & Co., New York) are named as indicating the nature and extent of this requirement, and an acquaintance with one of these works will be required unless some satisfactory substitute is offered. In the last-named course one-third of each exercise may, if desired, be omitted.) (2) Cæsar—six books of the Gallic War, or their equivalent. (As advantageous substitutes for the last three books of Cæsar may be suggested three books of Vergil's Æneid, or a similar quantity of Ovid.)

Arithmetic—Fundamental Operations, Least Common Multiple, Greatest Common Divisor, Common and Decimal Fractions, Denominate Numbers, including the Metric System of Weights and Measures: Percentages, including interest, Discount, and Commission; Proportion, Extraction of the Square and Cube Roots.

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Algebra—Fundamental Operations, Fractions, Equations of the First Degree, with one or several unknown quantities; Inequalities, Ratio and Proportion, Involution, including the Binomial Formula for an entire and positive Exponent; Evolution, the Reduction of Radicals, Equations of the Second Degree, Progressions, Permutations and Combinations, the Method of Indeterminate Coefficients, Fundamental Properties of Logarithms, Compound Interest.

Geometry—Plane, Solid, and Spherical; including fundamental notions of Symmetry, and examples of Loci and Maxima and Minima of Plane Figures.

Trigonometry—including the Analytical Theory of the Trigonometrical Functions, and the usual formulæ; the Construction and use of Trigonometrical Tables; and the Solution of Plane Triangles; so much, for example, as is contained in Newcomb's Trigonometry to Art. 79, or in Wheeler's or Richards's Plane Trigonometry. The Logarithmic and Trigonometric Tables furnished at the Examination will be Newcomb's (Henry Holt & Co., New York, 1882).

While no entrance examination is held in the *History of England*, candidates for admission are urgently advised to make themselves as familiar as possible with that subject; as a knowledge of it is essential to the most successful prosecution of some of the studies of the course.

Candidates will be allowed the option of passing on the above-named subjects in two successive years. In such a case they must present themselves for examination at the June examination of the first year in the following subjects or parts of subjects: *History of the United States*, *Geography*, *Arithmetic*, *Plane Geometry*, and *Algebra to Quadratic Equations*.

In order to have this preliminary examination counted, candidates must pass satisfactorily on *all* the subjects; and notice must be given of the intention to divide the examination to Professor G. J. Brush, Executive Officer of the School, on or before June 15.

For preparation in Algebra and Geometry the recently published text-books of Professor Newcomb on these subjects (Henry Holt & Co., New York, 1881), may, without indicating undue preference, be especially recommended. And to the candidate who prepares in other works, they may serve to indicate the extent and kind of attainments expected in the prescribed topics. Candidates who prepare in the Geometry of this author, may for the present omit the short chapters on the Ellipse, Hyperbola, and Parabola; though they will find it advantageous to study them.

In his preparation in GEOMETRY the candidate should, as far as practicable, have suitable exercises in proving simple theorems and solving simple problems for himself. It is important, too, that he should be accustomed to the numerical application of geometric principles, and especially to the prompt recollection and use of the elementary formulæ of mensuration. In TRIGONOMETRY he should be exercised in applying the usual formulæ to a variety of simple reductions and transformations, including the solution of trigonometrical equations. Readiness and accuracy in trigonometrical calculations are also of prime importance to the candidate. If the use of logarithms is postponed in his preparation till Trigo-

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nometry is taken up (which is by no means necessary or advisable), he should then have abundant applications of them to all forms of calculation occurring in ordinary practice, as well as to those appearing in the solution of triangles. Finally, in all of his calculations, he should study the art of neat and orderly arrangement.

In LATIN the student should have such continued training in parsing as shall make him thoroughly familiar with declensions and conjugations, and with the leading principles of Syntax. To secure these results more effectually, the requirement has been adopted of simple exercises in translating English into Latin. As this course of exercises is designed solely as a preparation for reading, it should be begun at the earliest stage of Latin study. A very large proportion of the deficiencies in the Latin examination for several years past has been due to the neglect of the suggestions of this paragraph, and to the attempt to read a Latin author with totally inadequate grammatical preparation.

The examinations for admission take place at North Sheffield Hall, on Thursday, Friday, and Saturday, June 28, 29, 30, and on Tuesday and Wednesday, September 11, 12, 1883. Opportunities for private examinations may, in exceptional cases, be given at other times.

In 1883 examinations (for the Freshman Class only) will also be held in Andover, Mass., in Chicago, in Cincinnati, and in San Francisco (beginning on Thursday, June 28, at 9 A. M.), at places to be announced in local newspapers of the day previous. Candidates who propose to be present are requested to send their names to Professor G. J. Brush, Executive Officer of the School, before June 15. A fee of five dollars will be charged for admission to the examinations outside of New Haven.

Candidates for advanced standing in the undergraduate classes are examined, in addition to the preparatory studies, in those already pursued by the class they wish to enter. No one can be admitted as a candidate for a degree, later than at the beginning of the Senior year.

THE COURSES OF INSTRUCTION, occupying three years, are arranged to suit the requirements of various classes of students. The first year's work is the same for all; for the last two years the instruction is chiefly arranged in special courses.

The special courses most distinctly marked out are the following:—

(*a.*) In Chemistry; (*b.*) In Civil Engineering;
(*c.*) In Dynamical (or Mechanical) Engineering;
(*d.*) In Agriculture; (*e.*) In Natural History;
(*f.*) In Biology preparatory to Medical Studies;
(*g.*) In studies preparatory to Mining and Metallurgy;
(*h.*) In Select studies preparatory to other higher studies.

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The arrangement of the studies is indicated in the annexed scheme.

FRESHMAN YEAR—INTRODUCTORY TO ALL THE COURSES:

FIRST TERM—*German*—Whitney's Grammar and Reader. *English*—Lounsbury's History of the English Language; Exercises in composition. *Mathematics*—Spherical Trigonometry (Newcomb's); Plane Analytical Geometry. *Physics*—Recitations, with experimental lectures. *Chemistry*—Recitations and Laboratory practice. *Elementary Drawing*—Practical Lessons in the Art School.

SECOND TERM—*Language, Physics, and Chemistry*—as stated above. *Mathematics*—Plane Analytical Geometry, continued. *Physical Geography*—Lectures. *Botany*—Gray's Lessons, with Lectures. *Drawing*—Isometric Drawing, with application to drawing from models and structures by measurement. Shading and tinting. Principles of orthographic projection. Reading of working drawings and isometric construction of objects from their orthographic projections. Sections.

For the Junior and Senior years the students select for themselves one of the following courses:

(a.) IN CHEMISTRY:

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. *Qualitative Analysis*—Fresenius's. *Laboratory Practice. Blowpipe Analysis. German. French.*

SECOND TERM—*Theoretical Chemistry*—continued. *Laboratory Practice*—Quantitative Analysis, and experimental work in Organic Chemistry. *Mineralogy*—Blowpipe Analysis and determination of species. Lectures. *French. German.*

SENIOR YEAR:

FIRST TERM—*Organic Chemistry*—Lectures and Recitations. *Agricultural Chemistry*—Recitations (optional). *Laboratory Practice*—Volumetric and Mineral Analysis. *Geology*—Dana's. *Zoölogy*—Lectures. *French.*

SECOND TERM—*Organic Chemistry*—continued. *Laboratory Practice*—Analysis of Minerals and Technical Products. *Assaying* (optional). *Geology*—Dana's Manual. *Mineralogy* (optional). *French.*

(b.) IN CIVIL ENGINEERING:

JUNIOR YEAR:

FIRST TERM—*Mathematics*—Analytical Geometry of Three Dimensions; Elements of the Theory of Functions; Differential Calculus. *Surveying*—Field Operations. *Drawing*—Descriptive Geometry, begun. *German. French.*

SECOND TERM—*Mathematics*—Integral Calculus; Rational Mechanics. *Drawing*—Descriptive Geometry, concluded; Topographical. *Surveying*—Topographical. *German. French.*

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SENIOR YEAR:

FIRST TERM—*Field Engineering*—Laying out Curves; Location of Line of Railroad, with calculations of Excavations and Embankment; Hencks's Field Book for Railroad Engineers; Searles's Field Engineering. *Civil Engineering*—Resistance of Materials; Bridges and Roofs, begun; Stone Cutting, with Graphical Problems. *Geology*—Dana's. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *French.*

SECOND TERM—*Civil Engineering*—Bridges and Roofs; Building Materials; Stability of Arches and Walls; Mahan's Civil Engineering. *Dynamics*—Principles of Mechanism; Steam Engine. *Hydraulics*—Hydraulics and Hydraulic Motors. *Drawing*—Graphical Statics. *Astronomy*—Loomis's Astronomy with practical problems. *Mineralogy*—continued. *Geology*—Dynamic. *French.*

(c.) IN DYNAMIC ENGINEERING:

JUNIOR YEAR:

FIRST TERM—*Mathematics*—Analytical Geometry of Three Dimensions; Elements of the Theory of Functions; Differential Calculus. *Surveying*—Field Practice. *Drawing*—Descriptive Geometry, begun. *German. French.*

SECOND TERM—*Mathematics*—Integral Calculus. Rational Mechanics. *Kinematics*—General Theory of Motion and Principles of Mechanism; Elementary Combinations of Pure Mechanism; Pulleys and Belts; Gearing and forms of teeth for Wheels; Parallel Motions. *Drawing*—Descriptive Geometry, concluded. *German. French.*

SENIOR YEAR:

FIRST TERM—*Statics*—Application of the Principles of Statics to Rigid Bodies; Elasticity and Strength of Materials; Forms of Uniform Strength; Stability of Structure; Construction of Roof Trusses, Girders, and Iron Bridges. *Machine Drawing*—Bolts and Nuts; Riveting; Journals, Axles, Shafts, Couplings, Pillow Blocks; Shaft-hangers, Pulleys; Connecting Rods and Cranks; Cross-heads; Pipe connections; Valves; Steam Cylinders, Stuffing Boxes, Glands, etc. Shop Visits. *Blowpipe Analysis. French.*

SECOND TERM—*Hydrostatics and Hydrodynamics*—Equilibrium and Pressure of fluids; Hydrometers, Manometers, Gauges, etc.; Water Pressure Engines and Water Wheels; Construction of Water Reservoirs and Conduits; Measurement of Water Supply; Discharge of pipes. *Thermodynamics*—General Principles of Heat employed as a source of power; Theory of the Steam Engine: Hot Air Engines; Gas Engines. *Machine Designing*—Proportioning of Machine Parts, continued; Designing of Hoisting Engines; Shearing and Pumping Engines; Complete working drawings for a high speed Steam Engine. Shop Visits and Reports. *Metallurgy.*

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(d.) IN AGRICULTURE:

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. *Qualitative Analysis*—Fresenius's. *Laboratory Practice. Blowpipe Analysis. German. French.*

SECOND TERM—*Theoretical Chemistry*—continued. *Laboratory Practice*—Quantitative Analysis. *Mineralogy*—Blowpipe Analysis and Determination of Species. *Physiology*—Huxley's. *Botany. French. German.*

SENIOR YEAR:

FIRST TERM—*Agriculture*—Cultivation of the Staple Crops of the Northern States. Tree Planting and Forestry. *Agricultural Chemistry*—Johnson's. *Organic Chemistry*—Lectures and Recitations. *Geology*—Dana's. *Botany. Zoölogy. English. French.*

SECOND TERM—*Agriculture*—Laws of Heredity and Principles of Breeding; Lectures. *Geology*—Dana's. *Rural Economy*—Systems of Husbandry. *Agricultural Chemistry*—Johnson's. *Organic Chemistry*—continued. *Geology*—Dana's. *Zoölogy. Botany. Microscopy. English. French.*

(e.) IN NATURAL HISTORY:

(Either Geology, Mineralogy, Zoölogy, or Botany, may be made the principal study, some attention in each case being directed to the other three branches of Natural History.)

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. *Qualitative Analysis*—Fresenius's; Laboratory Practice; Recitations. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *Botany*—Gray's Manual; Laboratory Practice. *German. French.*

SECOND TERM—*Zoölogy*—Laboratory Practice; Recitations; Excursions (land and marine). *Botany*—Laboratory Practice; Excursions. *Physiology*—Huxley's. *Mineralogy*—continued. *Physical Geography. German. French.*

SENIOR YEAR:

FIRST TERM—*Geology*—Dana's: Excursions. *Zoölogy*—Laboratory Practice; Lectures; Recitations; Excursions. *Botany*—Herbarium Studies; Gray's Textbook; Excursions. *French.*

SECOND TERM—*Geology*—Dana's. *Anatomy of Vertebrates*—Huxley's. *Zoölogy*—Laboratory Practice; Recitations; Lectures. *Botany*—Herbarium Studies, especially in the Cryptogamous Orders; Botanical Literature; Essays in Descriptive Botany. *Meteorology. French.*

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Besides the regular courses of recitations and lectures on structural and systematic Zoölogy and Botany, and on special subjects, students are taught to prepare, arrange, and identify collections, to make dissections, to pursue original investigations, and to describe genera and species in the language of science. For these purposes, large collections in Zoölogy and Palæontology belonging to the College are available, as are also the private botanical collections of Professor Eaton.

(f.) IN BIOLOGY PREPARATORY TO MEDICAL STUDIES:

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. *Qualitative Analysis*—Fresenius's; Laboratory Practice; Recitations. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *German*. *French*.

SECOND TERM—*Physiology*—Huxley's; Practical Exercises. *Theoretical Chemistry*—continued. *Physiological Chemistry*—Sanderson's Handbook; Recitations and Laboratory Work. *Mineralogy*—continued. *Botany*—Lectures; Practical Exercises in Phenogamous Plants; Excursions. *German*. *French*.

SENIOR YEAR.

FIRST TERM—*Physiological Chemistry*—continued. *Toxicology*—Laboratory Practice and Lectures. *Organic Chemistry*—Lectures and Recitations. *Zoölogy*—Lectures. *Botany*—Practical Exercises; Lectures and Excursions. *Geology*—Dana's Manual. *French*.

SECOND TERM—*Comparative Anatomy and Histology*—Laboratory Practice and Recitations. *Human Anatomy and Physiology*—Recitations. *Geology*—Dana's Manual. *Zoölogy*—Lectures. *Laws of Heredity and Breeding*—Lectures. *French*.

(g.) IN STUDIES PREPARATORY TO MINING AND METALLURGY:

Young men desiring to become Mining Engineers can pursue the regular course in Civil or Mechanical Engineering, and at its close can spend a fourth year in the study of metallurgical chemistry, mineralogy, etc.

(h.) IN THE SELECT STUDIES PREPARATORY TO OTHER HIGHER STUDIES:

JUNIOR YEAR:

FIRST TERM—*Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *Physical Geography*—Guyot; Lectures. *English*—Early English. *History*—Green's Short History of the English People. *French*. *German*.

SECOND TERM—*Mineralogy*—Lectures. *Astronomy*. *Botany*—Lectures; Excursions; Laboratory Practice. *English*—Chaucer, Bacon, Shakspere. *History*—Green's History, continued; History of the United States. *German*. *French*.

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SENIOR YEAR.

FIRST TERM—*Geology*—Recitations and Excursions. *Zoölogy*—Lectures and Excursions. *Linguistics*—Whitney's Life and Growth of Language. *English*—Shakspere. *Constitutional Law of the United States. French.*

SECOND TERM—*Geology*—continued. *Meteorology*—Lectures. *Sanitary Science*—Lectures. *Political Economy*—Recitations and Lectures. *English*—Shakspere, Milton, Dryden, Pope, Gray, and later authors. *French.*

Exercises in English Composition are required during the entire course from all the students. The preparation of graduating theses is among the duties of the Senior Year.

Lectures on Military Science and Tactics are annually given by General Abbot, and other officers of the Engineer Corps of the United States Army.

DRAWING.—The course in drawing extends through the three years. During the first term of Freshman year, the students practice free-hand drawing at the Art School building, under the direction of Professor Niemeyer, of the Yale School of the Fine Arts. After the completion of the course in free-hand drawing, instruction is given by Mr. F. R. Honey, during the second term in the elementary principles of instrumental drawing, embracing Elementary projection drawing, Isometric drawing, and Descriptive Geometry as far as Warped Surfaces. This course is obligatory upon all.

During the Junior and Senior years, instruction in drawing is obligatory only on the students in Civil and Mechanical Engineering. In the former year the system of instruction embraces shades and shadows, tinting, perspective, and warped surfaces. By this method all the problems in Descriptive Geometry are required to be worked out on the drawing-board instead of the black-board. The course extends through the entire year, and is under the direction of Mr. Honey.

In Senior year, students are required to apply the principles of drawing already obtained to works of construction, under the general supervision of the Professors of Civil and of Dynamic Engineering.

VII.

METHODS OF INSTRUCTION.

The instruction of this institution is given chiefly in small class-rooms, in connection with recitations and by familiar lectures, illustrated by the apparatus at the command of the various

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teachers. In many studies weekly excursions are made for the purpose of collecting specimens and examining natural phenomena.

In Chemistry and Metallurgy the students work several hours daily in well-appointed laboratories, under the direct superintendence of the instructors, and are guided through systematic courses of quantitative and qualitative analysis, assaying, and the blow-pipe determination of minerals and ores.

In the course in Biology, instruction in Comparative Anatomy and Histology is given in the laboratory five or six mornings each week; the student working out for himself, by dissection and the examination of preparations, the anatomy of several types of animals, and making a large part of the microscopical preparations used in the study of the different tissues. In Physiological Chemistry the student works four hours daily in the study of the chemical processes of the body and in the preparation and examination of the more important proximate principles; thus, under the head of nutrition the various digestive processes are suggestively studied, artificial digestions are made, the products are separated and examined, while their physiological functions are demonstrated by experiments on animals. Special attention is also paid to the micro-chemistry of the various tissues. Students are likewise trained in qualitative and quantitative analysis of urine, both in health and in disease, not alone for the practical results to be obtained, but especially for the means which it affords of studying the metabolic changes of the body. Toxicology is taught by experiments on animals; the absorption and elimination of poisons, together with other points of physiological value, being demonstrated by chemical analysis of tissues and secretions. In each of these subjects laboratory instruction is supplemented by recitations and lectures.

In Botany, during the summer of Junior year, exercises in analyzing and identifying plants occur two or three times a week, followed by practice in writing characters and descriptions of plants from living specimens. Students are shown also the best methods of collecting and preserving for future study, specimens of Flowering Plants, Ferns, Mosses, Algæ, etc. In the autumn term of Senior year the work of the summer is continued. Students are encouraged to pursue special lines of Botanical investigation, and varied assistance is rendered them according to their needs. The final examination is intended to show what they have learned, and the collections they have made are considered to be of minor importance.

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In Zoology excursions are made during the Summer term of Junior and Fall term of Senior year, in company with the instructors, for the purpose of observing the habits and making collections of marine, fresh-water, and terrestrial animals of all classes. Each student is required to prepare and present for examination a collection containing a specified number of species, and illustrating the various classes of animals. He must also be able to pass an examination upon his collection, at least to the extent of explaining the classes and orders illustrated, and showing why particular specimens belong to the respective classes.

In Geology excursions are made for the purpose of examining geological phenomena and making special collections of rocks and minerals. Each student is required to pass a satisfactory examination on his collections at the end of the first term of Senior year.

In Civil Engineering the students, besides attending on Class recitations and lectures, pursue a systematic course of exercises in the different branches of Geometrical Drawing and Graphical Statics, and in the application of the principles of drawing to works of construction; and have good practice in the operations of Surveying and Field Engineering—acquiring facility in the use and adjustment of Surveying and Engineering Instruments. In Topographical Surveying they are instructed in the use of the Plane Table for topographical work, and are required to prepare a detailed chart of the ground surveyed—exhibiting the contour lines and all its topographical features. Numerous problems of computation, and graphical exercises, are included in the Course of Construction pursued in the Senior year. A course of Blowpipe Analysis is also taken by the Senior Class, that a more thorough knowledge may be gained of minerals and building stones.

In Dynamic Engineering the method of instruction is by recitation and lectures, supplemented by work in the drawing room, by shop visits, and visits of inspection in and out of the city, and by tests with the indicator and dynamometer. The lectures are illustrated by models, by large cartoons adapted for the purpose, and by the complete collection of working drawings of the Novelty Iron Works, owned by the School. In the drawing room, detailed working drawings of various machines are made. A general sketch of the proposed machine is given and complete detailed drawings are required, in proper shape for the pattern-maker or machinist. The student is taught the best practice, and his judgment is trained in choosing relative

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proportions. The student is required to describe the steps to be followed in building the machine, and to make as nearly as possible an estimate of its cost. Pattern, foundry, blacksmithing and machine work are studied in detail. In the visits, machinery and processes are critically examined in detail, and sketches of important machines with written descriptions are required.

In addition to the above, a course of lectures is given every winter by the professors of the schools and others, on topics of popular interest.

VIII.

TUITION CHARGES.

The charge for tuition for undergraduate students is $150 per year, payable, $55 at the beginning of the first and of the second term, and $40 at the middle of the second term. The student in the Chemical course has an additional charge of $70 per annum for chemicals and use of apparatus. He also supplies himself at his own expense with gas, flasks, crucibles, etc., the cost of which should not exceed $10 per term. A fee of $5 is charged members of the Freshman Class for chemicals and materials used in their laboratory practice, and the same fee is required from all (except Chemical students) who take the practical exercises in Blow-pipe Analysis and Determinative Mineralogy. A fee of $5 a term will also be charged to the students in the Zoölogical laboratory, for materials and use of instruments. An additional charge of $5 is annually made to each student for the use of the College Reading Room and Gymnasium.

For graduate students the charge for tuition is $100 per year.

IX.

CHURCH SITTINGS.

Free sittings for students in this department of Yale College are provided as follows: in the Center Church (Congr.); in the Trinity (Episc.); and in the First Methodist Church.

Those who prefer to pay for a sitting for a year, more or less, in the churches above mentioned, or in any other church of any denomination, will be aided on application to the Secretary of the School.

Sittings in the Gallery of the College Chapel are free as heretofore to the students of this department.

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X.

DEGREES.

Students of this department, on the recommendation of the Governing Board, are admitted by the Corporation of Yale College to the following degrees. They are thus conferred:

1. Bachelor of Philosophy: on those who complete any of the three-years courses of study, passing all the examinations in a satisfactory manner, and presenting a graduation thesis.

The fee for graduation as Bachelor of Philosophy, including the fee for Triennial Catalogues, Commencement Dinners, etc., is $10; unless the person taking the degree is also an academical graduate, when it is but $5.

2. Civil Engineer and Dynamical Engineer: The requirements for these degrees are stated on page 21.

3. Doctor of Philosophy: The requirements for this degree are stated on page 17.

XI.

TERMS AND VACATIONS.

The next academic year begins Thursday, September 13, 1883. The first term begins eleven weeks from Commencement-day and continues fourteen weeks: the second term begins on the second Thursday in January and continues until Commencement-day, with a Spring recess—usually of eight days—including Easter. (See Calendar, p. 2.)

XII.

ANNOUNCEMENT IN RESPECT TO STATE STUDENTS.

The scholarships established in this School in consequence of the bestowal upon it of the Congressional grants are designed to aid young men who are in need of pecuniary assistance in fitting themselves for agricultural and mechanical pursuits of life. All applicants must be citizens of Connecticut. In case there are more applicants than vacancies, candidates will be preferred who have lost a parent in the military or naval service of the United States, and next to these such as are most in need of pecuniary assistance; and the appointments will be distributed as far as practicable among the several counties in proportion to their population. The appointing Board for the current year, consist-

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ing of the Board of Visitors of the State and the Secretary of the School, will meet on June 26th, 1883, and at or about the same time in the year 1884, due notice of which will be given by publication in every county of the State. All applications should be made previous to that time. Blank forms for application will be sent, when requested, by Professor GEORGE J. BRUSH, Secretary of the Appointing Board.

XIII.

ANNIVERSARY.

The Anniversary of the School is held on Tuesday of the Commencement week in Yale College, when selections from the graduation theses are publicly read. The degrees are publicly conferred by the President and Fellows of Yale College on Commencement Day.

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APPENDIX.

ENTRANCE EXAMINATION PAPERS.

The following are the papers for 1882, upon which applicants for admission were examined at the June and September examinations.

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ARITHMETIC.

JUNE, 1882.

1. Find the greatest common divisor of 17640 and 18375.

2. Find the least common multiple of the foregoing numbers.

3. Give the table of Troy weights; also, the table of Metric weights. Express the gram in grains and the kilogram in pounds avoirdupois.

4. Express $\frac{32\frac{1}{6}}{75\frac{3}{5}}$ decimally to three places.

5. Of an alloy containing 21 parts copper and 4 parts nickel, what per cent. is copper and what per cent. nickel?

6. For what amount must a note payable in 60 days be given to a bank discounting at 6 per cent. to obtain $500.

7. If 16 men build 18 rods of wall in 12 days, how many men will be needed to build 72 rods in 8 days.

8. Extract the square root of .001601 to four places.

ARITHMETIC.

SEPTEMBER, 1882.

1. (*a*) Which of the numbers 293, 371, 385, 440, 524, 617 and 713 are prime?

(*b*) Separate 1836 into its prime factors.

2. Divide $\frac{\frac{7}{8}}{\frac{3}{11}}$ of $12\frac{1}{2}$ by $\frac{\frac{1}{8}}{7\frac{1}{2}}$ of $8\frac{3}{4}$.

3. Divide .000744 by .62, and explain the position of the decimal point in the quotient.

4. In 80937864 square inches how many acres?

5. Q and Y barter; Q makes of 10 cents $12\frac{1}{2}$ cents; Y makes of 15 cents 19 cents; which makes the most per cent., and how much?

6. Three men harvested and thrashed a field of grain on shares, A furnishing 4 hands 5 days, B 6 hands 4 days, and C 5 hands 8 days. The whole crop was 630 bushels, of which they had $\frac{1}{7}$. How much did each receive?

7. Extract the cube root of $81\frac{5}{11}$ to three decimal places.

8. Bought 30 metres of cloth at $2.50 per metre, at what price per yard must it be sold to gain $25?

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GEOMETRY.

JUNE, 1882.

NOTE 1.—Candidates for examination in this subject as a whole should take the whole of this paper; those for the first year's partial examination, the first part of it; those for the second year's partial examination, the second part.

NOTE 2.—State at the head of your paper what text-book you have studied on the subject, and to what extent.

I.—PLANE GEOMETRY.

1. (*a*) Define and illustrate the symmetry of a figure with reference to an axis and with reference to a point. (*b*) Define the different classes and species of quadrilaterals.

2. The three medial lines of a triangle meet in a point which is at two-thirds the distance from the vertex of each angle to the middle of the opposite side.

3. To inscribe a circle in a given triangle. Define *escribed* circles relative to a triangle.

4. The bisector of an interior angle of a triangle divides the opposite sides into segments proportioned to the adjacent sides.

5. When is variable magnitude said to have a *limit?* Give an example to illustrate the definition.

6. If two sides of a triangle be given, its area will be a maximum when these sides are at right angles.

II.—SOLID AND SPHERICAL GEOMETRY.

7. If a straight line is perpendicular to each of two straight lines at their point of intersection, it is perpendicular to the plane of these lines.

8. Define symmetrical polyhedral angles. Illustrate the definition by a figure.

9. Define the poles of a circle of a sphere. Prove that all points on the circumference of a circle of a sphere are equally distant from each of its poles.

10. The angle between two great circles is equal to the dihedral angles between their planes.

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GEOMETRY.

SEPTEMBER, 1882.

[State what text-book you have studied, and to what extent.]

1. An inscribed angle is measured by one-half its intercepted arc.

2. From a given point without a circle to draw a tangent to the circle.

3. To construct a triangle which shall be equal in area to a given quadrilateral.

4. The diameters of two concentric circles being 10 and 6 feet, required the area of the ring contained between their circumferences.

5. The sum of any two face angles of a trihedral angle is greater than the third.

6. The lateral area of a frustrum of a regular pyramid is equal to its slant height into half the sum of the perimeters of its bases.

7. Write expressions for the volume of the sphere and right cylinder. Show that the volume of a sphere is to that of its circumscribed cylinder as 2 to 3.

8. Required the area of a spherical triangle described on a sphere, whose diameter is 30 feet, the angles being 140°, 92°, and 68°.

ENGLISH GRAMMAR.

JUNE, 1882.

1. Define *noun* and *verb*.

2. Name the relative pronouns. State in reference to what each is used.

3. Give examples of three verbs with their principal parts from each one of the two English conjugations—the old (or strong), and the new (or weak).

4. Parse the following:—

I here declare those whom I did accuse
Are innocent. 'Tis I alone am guilty.

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ALGEBRA.

JUNE, 1882.

NOTE 1.—Candidates for examination in this subject as a whole should take the whole of this paper; those for the first year's partial examination, the first part of it; those for the second year's partial examination, the second part.

NOTE 2.—State at the head of your paper what text-book you have studied on the subject, and to what extent.

I.

1. Resolve x^3+8y^3 into two factors.

2. Given $\frac{10a-5x}{a+b}-\frac{5a-x}{a-b}=cx$, to find the value of x.

3. There are three workmen, A, B, C. A and B together can perform a certain piece of work in a days; A and C together, in b days; and B and C together, in c days. In what time could each singly perform it, and in what time could they finish it if all worked together.

4. Prove that if $\frac{a_1}{b_1}=\frac{a_2}{b_2}=\frac{a_3}{b_3}=r$, then

$$\frac{a_1+a_2+a_3}{b_1+b_2+b_3}=r.$$

5. (*a*) Write equivalent expressions for the following:

$$a^0,\ a^{-m},\ \sqrt[3]{a^5}.$$

(*b*) Reduce the following expressions to simpler forms.

(1) $\sqrt{45c^3}-\sqrt{80c^3}+\sqrt{5a^2c}$

(2) $\left[\left(\frac{a^{-2m}}{b^{-2n}}\right)^{\frac{p}{m}}\right]^{\frac{q}{2n}}$

(3) $4^3\sqrt{\frac{2}{3}}\times 2\sqrt{\frac{3}{4}}$

II.

6. Given $3x^2+x=7$, to find x.

7. Given $\frac{\sqrt{p+x}+\sqrt{p-x}}{\sqrt{x}}=\sqrt{\frac{x}{q}}$, to find x.

8. Given $x+y=a$; $x^2+y^2=b^2$, to find x and y.

9. Expand $\frac{1+2x}{1-3x}$ into a series by the method of indeterminate coefficient.

10. Write equivalent expressions adapted to computation for the following:

(1) $\log\left(\frac{a^m b^n}{c^p}\right)$ (2) $\log\sqrt{a^2-x^2}$.

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ALGEBRA.

SEPTEMBER, 1882.

[State what text-book you have studied on the subject, and to what extent.]

1. Multiply $\frac{x^4-b^4}{x^2+2bx+b^2}$ by $\frac{x^2+bx}{x-b}$ so as to obtain the product in its simplest form.

2. Given $x-\frac{y-a}{b}=c$ and $y-\frac{a-x}{b}=d$, to find x and y.

3. Given $\sqrt{4a+x}=2\sqrt{b+x}-\sqrt{x}$, to find x.

4. Write the 6th power of $(a-2b)$ by the binomial formula.

5. Simplify the following expressions:

$$(a)\ \left(x\frac{p}{q}\right)^n;\ (b)\ \sqrt[5]{\frac{32m^5n^{10}}{p^{15}q^{20}}};\ (c)\ \sqrt[4]{36a^2b^2};$$

$$(d)\ \sqrt{8}+\sqrt{50}-\sqrt{18};\ (e)\ 3a\sqrt[6]{b}\times 5b\sqrt{2c}.$$

6. Solve the equation $6x^2-13x+6=0$, and resolve the first member into its factors.

7. Given $x+y=p$ and $xy=q^2$, to find x and y.

8. A traveler has a journey of 132 miles to perform. He goes 27 miles the first day, 24 the second, and so on, traveling 3 miles less each day than the day before. In how many days will he complete the journey?

9. What is the present value of a dollars due n years hence, at c per cent. compound interest?

10. How many distinct straight lines can be drawn in joining two and two five distinct points, no three of which are in the same straight line?

TRIGONOMETRY.

JUNE, 1882.

[State what text-book you have studied on the subject, and to what extent.]

1. Define the different trigonometric functions of an angle.

2. Give the algebraic sign for each function of an angle terminating in each of the four quadrants.

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3. Show that $\sin(\pi+\alpha)=-\sin\alpha$; and that

$$\cos(2\pi-\alpha)=\cos\alpha.$$

4. Find the formula for $\tan(\alpha+\beta)$ in terms of $\tan\alpha$ and $\tan\beta$. Find also the formula for $\tan 2\alpha$ in terms of $\tan\alpha$.

5. Given $2a\tan\theta\sin\theta-2a\cos\theta+b=0$, to find $\cos\theta$.

6. Given two sides of a plane triangle 180 and 100 and the angle opposite the former 127° 33′, to find the other parts.

TRIGONOMETRY.

September, 1882.

[State what text-book you have studied, and to what extent.]

1. Find the number of degrees in the angle subtended at the centre of a circle whose radius is 10 feet by an arc 9 inches long.

2. Determine all the functions of the following angles:

$$30°, \frac{\pi}{4}, \frac{5}{3}\pi, 585°.$$

3. Given the functions of any angle to find the functions of half that angle.

4. Given $\tan\theta=\frac{m}{n}$ to find the value of $\sin 2\theta$.

5. Show that $2\tan^{-1}a=\tan^{-1}\frac{2a}{1-a^2}$.

6. In a plane triangle, given $a=100$, $c=200$ and $B=112°\ 30'$, to find the remaining parts.

LATIN.

June, 1882.

I. Translate as literally as possible—

a. Relinquebatur una per Sequănos via, *qua*, Sequănis invitis, propter angustias ire non poterant. *His* quum suā sponte persuadere non possent, legatos ad Dumnorĭgem Aeduum mittunt, ut eo deprecatore a Sequănis impetrarent.

b. Nam quod ad hostes appropinquabat, *consuetudine* suā Caesar sex legiones expeditas ducebat: post eas totius exercitus impedimenta collocarat: inde duae legiones, quae proxime

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conscriptae erant, totum agmen claudebant *praesidioque impedimentis* erant.

c. Erant hae difficultates *belli gerendi*, quas supra ostendimus, sed multa Caesărem tamen ad id bellum incitabant, injuriae retentorum equitum Romanōrum, rebellio facta post deditionem, defectio datis obsidibus, tot civitatum conjuratio, imprimis, ne hac parte neglectā, reliquae nationes sibi idem licere arbitrarentur.

d. Diebus decem, quibus materia coepta erat comportari, omni opere effecto, exercitus transducitur. Caesar ad utramque partem pontis firmo praesidio relicto, in fines Sigambrōrum contendit. Interim a compluribus civitatibus ad eum legati veniunt, *quibus* pacem atque amicitiam petentibus liberaliter respondit obsidesque ad se adduci jubet.

e. Tunc duces principesque Nerviōrum, qui aliquem sermonis aditum causamque amicitiae cum Cicerōne habebant, colloqui sese velle dicunt. Factā potestate, eadem, quae Ambiŏrix cum Titurio egerat, commemorant: Omnem esse in armis Galliam, Germānos *Rhenum* transisse, Caesăris reliquorumque hiberna oppugnari.

f. In omni Galliā eorum hominum, qui aliquo sunt numero atque honore, genera sunt duo; nam plebes paene servorum habetur loco, quae nihil audet per se, nullo adhibetur consilio. Plerique, quum aut *aere* alieno aut magnitudine tributorum aut injuriā potentiorum premuntur, sese in servitutem dicant nobilibus: in hos eadem omnia sunt jura, *quae dominis* in servos.

II.—1. Decline *una* (1), *Sequanis* (1), *deprecatore* (4).

2. Compare *proxime* (7), *multa* (11), *firmo* (18).

3. Write the synopsis, active and passive, of *relinquebatur* (1).

4. State the mood and tense of the following: *impetrarent* (4), *collocarat* (7), *ostendimus* (10–11), *contendit* (19), *egerat* (25).

5. Give the principal parts of the following: *persuaderi* (3), *mittunt* (4), *claudebant* (8), *retentorum* (12), *neglecta* (14), *respondit* (21), *colloqui* (23), *velle* (24), *audet* (30), *adhibetur* (30), *premuntur* (32), *dicant* (32).

6. State the construction of all italicized words.

7. Quote (in full) from the above text an example of indirect statement.

8. Change into direct statement the example quoted in answer to question seventh.

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LATIN EXERCISES.

JUNE, 1882.

1. The Helvetians[1] send[2] embassadors[3] to[4] Dumnorix[5].

2. Embassadors are sent to Dumnorix by the Helvetians.

3. The Helvetians were not[6] able[7] to persuade[8] the Sequani[9].

4. The Helvetians say[10] (that) they are not able to persuade the Sequani.

5. (Re-write sentence fourth in such a manner as to illustrate direct statement.)

6. The Helvetians said: "we are unable to persuade the Sequani."

7. (Re-write sentence sixth in such a manner as to illustrate indirect statement.)

[1] Helvetius. [2] mittĕre. [3] legatus. [4] ad. [5] Dumnorix. [6] non. [7] posse. [8] persuadēre (governs Dative). [9] Sequanus. [10] dicĕre.

LATIN.

SEPTEMBER, 1882.

I.—Translate as literally as possible—

a. Ob eas causas ei *munitioni*, quam fecerat, Titum Labiēnum legatum praefecit; ipse in Italiam magnis *itineribus* contendit duasque ibi legiones conscribit, et tres, quae circum Aquilēiam hiemabant, ex hibernis educit; et qua proximum iter in ulteriorem Galliam per Alpes erat, cum his quinque legionibus ire contendit.

b. Quum se illi identidem in silvas ad suos reciperent ac rursus ex silvā in nostros impetum facerent, neque nostri longius, quam quem ad finem porrecta loca aperta pertinebant, *oedentes* insequi auderent; interim legiones sex, quae primae venerant, *opere* dimenso castra munire coeperunt.

c. Itaque Titum Labiēnum legatum in Trevĭros, qui proximi flumini Rheno sunt, cum equitatu mittit. *Huic* mandat, Remos reliquosque Belgas adeat atque in officio contineat, Germānosque. qui *auxilio* a Belgis arcessiti dicebantur, sĭ per vim *navibus* flumen transire conentur, prohibeat.

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d. Ipse cum omnibus copiis in Morinos proficiscitur, quod inde erat brevissimus in Britanniam trajectus. Huc naves undique ex finitimis regionibus et, quam superiore *aestate* ad Venetĭcum bellum *effecerat*, classem jubet convenire.

e. Cicĕro ad haec unum modo respondit: Non esse *consuetudinem* populi Romāni accipere ab hoste armato conditionem: si ab armis discedere velint, *se adjutore* utantur legatosque ad Caesărem mittant: sperare pro ejus justitiā, quae petierint, *impetraturos.*

f. Nam fere de omnibus controversiis publicis privatisque constituunt; et si quod est admissum facinus, si caedes facta, si de haereditate, de finibus controversia est, iidem decernunt; praemia poenasque constituunt. Si qui aut privatus aut populus eorum decreto non stetit, *sacrificiis* interdicunt. Haec poena apud eos est gravissima.

II.—1. Decline *munitioni* (1), *hibernis* (4), *ei* (1).

2. Compare *ulteriorem* (5), *primae* (10), *superiore* (19).

3. Write the synopsis, active and passive, of *conscribit* (3).

4. State the mood and tense of the following: *contendit* (6), *reciperent* (7), *auderent* (10), *conentur* (16), *velint* (23).

5. Give the principal parts of the following: *praefecit*, (2), *contendit* (6), *porrecta* (9), *auderent* (10), *dimenso* (11), *conentur* (16), *jubet* (20), *petierint* (24), *constituunt* (27), *decernunt* (28), *stetit* (30), *interdicunt* (30).

6. State the construction of all italicized words.

7. Quote (in full) from the above text an example of indirect statement.

8. Change into direct statement the example quoted in answer to question seventh.

LATIN EXERCISES.

September, 1882.

1. Caesar leads-forth[1] three[2] legions[3] from[4] winter-quarters[5].

2. Three legions are led-forth from winter-quarters by Caesar.

3. Caesar said[6] he would lead-forth three legions from winter-quarters.

4. (Re-write sentence third in such a manner as to illustrate direct statement.)

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5. Caesar said: I have led-forth three legions from winter-quarters.

6. (Re-write sentence fifth in such a manner as to illustrate indirect statement.)

7. Caesar having-hastened[7] into[5] Italy,[6] led forth three legions from winter-quarters.

[1] educĕre. [2] tres. [3] legio. [4] ex. [5] hiberna. [6] dicĕre. [7] contendĕre (use pluperf. subjunctive with *Quum*). [5] in. [6] Italia.

HISTORY OF THE UNITED STATES.

JUNE, 1882.

1. Give in chronological order the following dates: Settlement of Georgia, Bacon's Rebellion, foundation of St. Augustine, battle of Germantown, admission of Kentucky, secession of South Carolina.

2. Describe the settlement of Rhode Island.

3. What changes were made in the French possessions in America by the Treaty of Paris?

4. When did the first Continental Congress meet, and what did it do?

5. What was the Missouri Compromise?

6. Who were the presidential candidates in 1860?

HISTORY OF THE UNITED STATES.

SEPTEMBER, 1882.

1. Give in chronological order the following dates: Battle of Plattsburg, foundation of Rhode Island Colony, New England Confederation, discovery of the Hudson, admission of Missouri.

2. Describe the settlement of Georgia.

3. When and how did the United States acquire Louisiana and Florida?

4. What were the patroons?

5. What is the Monroe doctrine?

6. When and by what States was the Southern Confederacy formed?

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GEOGRAPHY.

JUNE, 1882.

1. Bound the State of Ohio;— name two cities in it and tell how they are situated.

2. Where does the Rio Grande River rise; where does it run and empty; and what States and Territories does it touch?

3. Where is Hindoostan; name two rivers in it and where they rise, which direction they run and where they empty; name two cities in it and how they are situated.

4. Bound Spain; what is its capital; name two chains of mountains in it and tell their situation.

5. Where are the following islands: Cyprus; Ceylon; Teneriffe; Trinidad; and Shetland?

6. How wide is the North Temperate Zone in English miles?

GEOGRAPHY.

SEPTEMBER, 1882.

1. Bound the State of Georgia; give the names of two cities in it; of two rivers in it; and what mountains are in it.

2. Where are the following cities: Buffalo, Denver, Milwaukee, Memphis, Louisville, Atlanta?

3. Give the names of three seaports in South America; tell what country each one is in, and how each is situated.

4. How is the Black Sea bounded; what waters are connected with it; name two rivers that empty into it and tell where they flow from.

5. Bound Morocco and describe its position.

6. Where is Lake Winnipeg; what river runs into it from the United States; what is its outlet and where does it empty?

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The Annual Report will be sent regularly to all graduates who may express the desire to receive it, and who furnish their addresses for the purpose.

For Circulars and other information, address

PROFESSOR G. J. BRUSH,

NEW HAVEN, CONN.

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EIGHTEENTH ANNUAL REPORT

OF THE

SHEFFIELD SCIENTIFIC SCHOOL

OF

YALE COLLEGE,

1883-84.

PRINTED BY ORDER OF THE GENERAL ASSEMBLY.

NEW HAVEN:
TUTTLE, MOREHOUSE & TAYLOR, PRINTERS.
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STATE BOARD OF VISITORS.

CONSTITUTING, WITH THE SECRETARY OF THE SCHOOL, THE BOARD FOR THE APPOINTMENT OF STATE STUDENTS

Governor

HIS EXCELLENCY THOMAS M. WALLER, New London

Lieutenant-Governor

HIS HONOR GEORGE G. SUMNER, Hartford

State Senators

HON. JOHN P. HILLS, Hartford
HON. O. B. KING, Watertown
HON. CHARLES D. YALE, Wallingford

Secretary of State Board of Education

CHARLES D. HINE

Secretary and Treasurer of the School

GEORGE J. BRUSH

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REPORT

OF THE

STATE BOARD OF VISITORS.

To the General Assembly of the State of Connecticut:

The State Board of Visitors, in presenting the Annual Report of the Sheffield Scientific School, take pleasure in commending its interesting details of the growth and prosperity of the institution to the special attention of your honorable body.

This department of Yale College has been opened a comparatively short time, but it has already two hundred and thirteen students representing twenty-three States and two Territories, and if it continues to receive the financial aid it deserves, it will be able, it is believed, within a few years to impart its advantages to more than double that number. It is a gratifying fact that State scholarships in this institution are eagerly sought, and that the records of those enjoying these favors are creditable to themselves and the State. The decrease of the amount of interest paid by Connecticut on money it holds, the income of which is devoted to the support of this

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school, reduces the number of scholarships to which the State is entitled. It is to be hoped that the deficiency will be met by a special appropriation so that at least thirty of our young men will continue to have the privilege of becoming, without cost of tuition, educated farmers, chemists, engineers or mechanics.

THOMAS M. WALLER,
Chairman.

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ANNUAL STATEMENT

OF THE

GOVERNING BOARD.

For the first time in the history of the Sheffield Scientific School, the Governing Board are under the necessity of recording the death of one of their number while in active service. At the very beginning of the present Academic year, William A. Norton, the head of the department of Civil Engineering, and the Senior Professor in the School, died after an illness of four days' duration. At the request of the Governing Board, the following sketch of his life and work has been prepared by Professor DuBois, who has held to him in turn the relation of pupil and of colleague, and during the past few years has been on terms of specially intimate friendship.

Sketch of Professor Norton's Life.

By the death of Professor Wm. A. Norton, the Sheffield Scientific School loses its oldest and one of its most widely known and beloved instructors. A teacher of more than fifty years' experience; an earnest and careful investigator; the School has had almost from its very inception—covering a period of more than thirty years—the benefit of his skill and zeal. With its growth and development he is identified, and to his faithful and devoted labors its success and reputation are largely due.

William Augustus Norton was born in East Bloomfield, New York, Oct. 25, 1810, and died Sept. 21, 1883, after an illness of but a few days, within a month of the completion of his 73d year. In 1827 he entered the Military Academy at West Point, where he

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graduated with high honors, and in 1831 was promoted Second Lieutenant Fourth Artillery, and assigned to duty as Acting Assistant Professor of Natural Philosophy in the Military Academy. He filled this position until 1833, with the exception of a few months, when he served with his regiment in the "Black Hawk War." In 1833 he resigned his position in the army, and was appointed Professor of Natural Philosophy and Astronomy in the University of the City of New York. This position he filled until 1839. He was afterwards Professor of Mathematics and Natural Philosophy in Delaware College, Newark, Delaware. This post he held for ten years, when he was elected President of the College, and served in this capacity during the year 1850. He then went to Brown University, Providence, Rhode Island, where he had charge of the Departments of Natural Philosophy and Civil Engineering. In 1852 he was elected Professor of Civil Engineering in Yale College, and in the autumn of that year he entered upon his duties with a class of twenty-six students who had followed their instructor from Brown University.

Since then, to the day of his death, he has ever been found at his post of duty, and many of his old pupils now filling responsible positions throughout the length and breadth of our country will testify to the practical value of his instructions, to his great capacity as a teacher, and to his character as a man. A teacher's best testimonial is the esteem and respect of his pupils, his best reward their love and confidence, and in this respect Prof. Norton stood very high. No teacher ever had more loyal students. It has been the privilege of the writer to be once his pupil, afterwards his colleague and always his friend, and during that period of seventeen years, he has never met or known any student to entertain or suffer any doubt of Prof. Norton's entire impartiality, his skill and fidelity as a teacher, or his friendly interest as a man. With a manner peculiarly genial and endearing in the class-room, frank and manly always and sometimes almost jovial—he made every student feel that his instructor was also his personal friend. No student of his ever acted upon this impression and found it to fail. Ever ready with suggestion, advice, aid and encouragement, always young at heart himself and believing thoroughly in the young men he taught, he was much more to them than the subjects he taught, and his personal influence was better than books. Many of his old pupils will learn of his death with keenest sorrow and will feel his loss as that of a friend.

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It is noteworthy that the same year which brought Prof. Norton to us from Brown University, gave us also his colleague in that institution—Prof. John A. Porter—whose early and lamented death at the age of forty-four deprived this department of one of its chiefest and most disinterested and self-sacrificing promoters.

Prof. Norton was not a man whose work began and ended in his class-room, and his scientific and educational contributions were numerous and important. Among these the chief published works are a "Treatise on Astronomy, Spherical and Physical," 1839, and a "First Book of Natural Philosophy and Astronomy," published in 1858. His scientific memoirs were contributed mostly to the *American Journal of Science*, the *Philosophical Magazine* (London), or read at meetings of the American Association for the Advancement of Science, or of the National Academy of Sciences. Of these, the following are some of the more important:

Terrestrial Magnetism.—*American Journal of Science*, second series, vol. iv.

Periodical Variations of the Declination and Directive Force of the Magnetic Needle.—*American Journal of Science*, 1855.

Ericsson's Caloric Engine.—*American Journal of Science*, 1853.

Donati's Comet, two memoirs.—*American Journal of Science*, 1859 and 1861.

Molecular Physics, two memoirs.—*American Journal of Science*, 1864 and 1872.

Principles of Molecular and Cosmical Physics.—*American Journal of Science*, 1870.

The Corona seen in Total Eclipses of the Sun.—*American Journal of Science*, 1870.

Physical Constitution of the Sun.—*American Journal of Science*, 1871.

Dynamical Theories of Heat.—*American Journal of Science*, 1873.

Laws of the Deflection of Beams Exposed to a Transverse Strain, Tested by Experiment.—*Proceedings of American Association*, 1870.

Physical Theory of the Principle of the Lever.—*Proceedings of American Association*, 1870.

Results of Experiments on the Set of Bars of Wood, Iron and Steel, after a Transverse Stress.—Two papers read before the National Academy of Sciences (April, 1874, and April, 1875). A succinct statement of the general conclusions of the two papers published in the *American Journal of Science*, April, 1876.

Results of Experiments on Contact Resistance.—Read before National Academy of Sciences, April, 1876; published in *American Journal of Science*, June, 1876.

The above list sufficiently indicates the scope and character of Prof. Norton's scientific labors. Those of them which pertain to engineering subjects are most valuable contributions to the science of which he was for so long a teacher. His investigation of Ericsson's Caloric Engine was thorough and masterly. Made

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at a time when the most extravagant expectations were widely entertained with regard to the new motor, his conclusions, expressed in the paper of 1853, are referred to and quoted to-day as one of the best expositions of the true nature, character and future of the hot air engine.

His experiments upon the Set and Transverse Strength and Deflection of Bars of Wood, Iron and Steel constitute a most important and valuable addition to engineering science. The experiments were conducted with great care and rare skill, and the value of the results has since been repeatedly acknowledged, and the results themselves incorporated into the standard text-books upon the subject. These papers are clear, precise and definite both in statement and description, qualities characteristic of all of Prof. Norton's work, whether in or out of the class-room.

Of his numerous contributions to the *American Journal of Science*, comprising some of the most earnest work of his life, that Journal speaks as follows (Nov., 1883):

"His earliest memoir was in the 46th volume of the first series, and was on the mode of formation of tails of comets. The manner of action of a solar repulsion in producing the comet's tails was developed at length. Some of the ideas, though original with Prof. Norton, had been anticipated by Olbers and Bessel. A series of papers followed upon the relations between the distribution of heat on the earth and the phenomena of terrestrial magnetism.

"From these he was led on to further discussion of magnetic action over the earth, and of like action, as he argued, in the body of the sun, and in the formation of the comas and tails of comets. These papers included especially an elaborate discussion of the famous comet of 1858.

"After this followed a series of papers on molecular physics, in which, starting from a few elementary assumptions, he arranged in one system the various phenomena of physics, explaining the gaseous, liquid and solid forms of matter, the various phenomena of electricity and magnetism, of light, heat, attraction, crystallization and chemical action; also explaining terrestrial, cometary and solar physics, the whole worked out in detail. Many of his conceptions and arguments are in direct opposition to widely accepted theories. But if some, or even if all of them shall, in the end, fail to be accepted as truths of nature, yet these memoirs will continue to testify to his love of truth, his painstaking labor and his complete grasp of the problems to be solved."

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In addition to the special purely scientific works above mentioned, Professor Norton was in 1859 appointed engineer on the part of the State of Connecticut to determine the boundary line in controversy between this State and that of New York.

Of late years Prof. Norton's contributions have been few, owing to his almost complete absorption in the preparation of a work which should present in systematic shape the views and conclusions above alluded to. Upon this work he based his claim to scientific reputation. He spoke of it always with enthusiasm, regarding his views as having passed out of the region of mere theory and as being capable of conclusive demonstration, and he ardently hoped that he might live long enough to complete the work. This we believe he did, but his sudden death has prevented his superintending its publication. It is to be hoped that it will yet see the light and constitute, as he always hoped it would, his best claim to scientific reputation.

Prof. Norton needs, however, no such work as his best claim to remembrance. That claim is best founded on his daily work as a beloved teacher and on his personal character as a true and high-minded man.

As a teacher the writer can speak from personal experience of his rare capacity, and any enthusiasm he might well be betrayed into while on this topic would be heartily endorsed by every one of his former pupils living to-day. And, as with the best teachers, the advantages unconsciously imbibed by his pupils from personal contact; the unconscious influence of high ideals; of love of truth and honor; of personal integrity; of scrupulous exactness—these were lessons daily enforced and more valuable than any of those he so well knew how to extract from the text-book or illustrate on the black-board. His patience and courtesy were unfailing. No student, however trying or dull, ever heard from him an impatient or sarcastic word. With perfect gentleness, a thoroughness which spared no pains, and a clearness of exposition which, in the writer's experience, is very rare, he took every student with him in the prescribed course, and sent him away at graduation, not only a wiser but a better man, and a personal and enthusiastic friend.

Prof. Norton was married in 1839 to Miss Elizabeth Emery Stevens, of Exeter, N. H., with whom for more than forty years he enjoyed that household happiness and content for which his kind, gentle, loving nature so eminently fitted him. Those who

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have been admitted to the intimacy of that little household of two know how pleasant it was and how good it was to be there. There, dropping the Professor, his students found always a hearty welcome, and a sympathizing friend, young at heart as themselves—a hearty, cordial and genial comrade.

The record of this long, useful, happy life; the lofty aims and high personal character which lay back of it; the simple faith and sincere convictions which ever guided it; the genial, manly qualities of heart and mind which adorned it; combine to make it one which claims and holds a foremost place in the long list of honored names—faithful teachers, sincere investigators and high-minded men—of which Yale College has a right to be and is most justly proud. The influence of such lives are the best heritage of universities, and their memories are a tower of strength to the institution which claims them, as well as an inspiration and example to the students and colleagues who cherish them.

Gifts.

Mr. Francis A. Livingston, of New York, father of Dr. Beverley Livingston (deceased), who graduated at the S. S. S. in 1874, has sent to the School in accordance with his son's request:

1. A copy of Harvey's *Nereis Boreali-Americana.*

2. A copy of Harvey's Wood's History of the Fresh-water Algæ of North America.

3. Sets of several medical journals for 1880–1883, including the London Lancet, Obstetrical Journal, Progrés Medicale, and many miscellaneous pamphlets on medical subjects; these have been transferred to the College Library.

4. A collection of many hundred microscopic slides, mostly illustrating human histology and pathology. The sections are very carefully prepared, stained and permanently mounted, and form a most valuable collection for the study of healthy and diseased tissues.

5. A collection of Algæ, Musci and other cryptogamous plants, made by Dr. Livingston, while a student here, and soon after graduation. The specimens are all well mounted and properly classified and include many duplicates.

The Library of the School has received for the second time a collection of valuable scientific works from Professor Wolcott Gibbs of Harvard University. The list, embracing over a hundred volumes, will be published in the next annual report.

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In connection with these gifts it is proper to refer to the loss which the Scientific School, as well as the whole community, has sustained in the death of Henry Farnam, one of the most generous and public-spirited citizens the city of New Haven has ever possessed. To this institution he was a liberal benefactor. In 1868 he made a gift of one thousand dollars. In the Annual Report for 1872, another gift of five thousand dollars is recorded as having been made by a friend of the School who preferred that his name should not be mentioned. The death of Mr. Farnam removes the injunction of secrecy, and it only needs to be said here that he was the person to whom reference was made.

Need of Increased Endowments.

In the number of students the Scientific School continues to show a steady and gratifying advance, and it is not unimportant to add that in excellence of preparation on the part of those desiring to enter, there also continues to be a marked improvement. But it is incumbent on the Governing Board to make known to the graduates and friends of the institution, that additional funds must be provided for its endowment if it is expected to maintain the position it has so long held. It is important to make this announcement because an impression widely prevails that its financial situation is far more favorable than is actually the case. The reduction of the rate of interest by the State of Connecticut from six to five per cent. on the money derived from the sale of the public lands, has reduced the annual income of the School from this source by the amount of thirteen hundred and fifty dollars. On the other hand, the munificent bequest of the generous founder of the School will not be available to its full extent for several years to come. In the meantime its annual income is about five thousand dollars less than during his life. While this diminution may be only temporary in its character, the fact is not to be disguised that unless provision of some kind is made to tide over the interval, it will be necessary, in order to meet current expenses, to encroach to some extent upon the principal of the funds held by the Trustees of the School. There is no need of saying that such action will be taken only as the last resource, but it is action that must inevitably be taken unless the friends of the institution can devise measures to enable the Governing Board to meet the deficit which is now threatened.

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States represented in the School.

The following table shows the States from which come the students whose names appear on the catalogue during the current year, and of the proportion of numbers that belong to each.

	Graduates.	Seniors.	Juniors.	Freshmen.	Special.	Total.
1. California	--	--	1	4	--	5
2. Colorado	--	2	--	2	--	4
3. Connecticut	6	18	25	28	1	78
4. District of Columbia	--	2	--	2	--	4
5. Georgia	--	1	--	2	--	3
6. Illinois	--	2	3	6	--	11
7. Indiana	--	1	1	--	--	2
8. Iowa	--	1	--	--	--	1
9. Kentucky	--	--	2	1	--	3
10. Maine	--	1	2	1	--	4
11. Michigan	--	--	1	3	--	4
12. Minnesota	--	--	1	3	--	4
13. Missouri	--	1	4	2	--	7
14. Nebraska	--	--	1	2	--	3
15. New Jersey	--	1	2	1	--	4
16. New York	3	9	18	14	1	45
17. Ohio	--	2	3	3	1	9
18. Oregon	--	--	1	--	--	1
19. Pennsylvania	--	4	6	5	--	15
20. Rhode Island	--	--	--	1	--	1
21. Texas	--	--	--	1	--	1
22. Vermont	--	--	--	1	--	1
23. Virginia	--	--	1	--	--	1
24. Washington Territory	--	--	--	1	--	1
25. Wisconsin	--	--	--	1	--	1
Totals	9	45	72	84	3	213

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Public Lectures.

The annual course of lectures to mechanics and others has been given during the past year. The lecturers and their subjects are indicated in the annexed programme:

I. Thursday, Feb. 8.—The Luray Caverns as seen by Electric Light. Rev. H. C. Hovey.
II. Tuesday, " 13.—The Transit of Venus. Prof. Newton.
III. Thursday, " 15.—Modern Fiction. Mr. Charles Dudley Warner.
IV. Tuesday, " 20.—Photo-Chemistry of the Retina. Prof. Chittenden.
V. Thursday, " 22.—The Trades-Unions of the Middle Ages. Prof. Farnam.
VI. Tuesday, " 27.—The History of Connecticut as illustrated in the Names of its Towns. Prof. Dexter.
VII. Thursday, Mar. 1.—Domestication of Animals. Prof. Brewer.
VIII. Tuesday, " 6.—Heat and Work. Prof. DuBois.
IX. Thursday, " 8.—Heat and Work. Prof. DuBois.
X. Tuesday, " 13.—The Veda. Prof. Whitney.
XI. Thursday, " 15.—Facts illustrative of the Darwinian Theory. Prof. Verrill.
XII. Tuesday, " 20.—The Agency of Insects in the Fertilization of Flowers. Dr. E. H. Jenkins.

Lectures on Military Science.

A course of Lectures on Military Science, by officers of the U. S. Engineering School, at Willetts Point, was delivered in North Sheffield Hall as a part of the instruction in the School during the second term of the academic year 1882–83. The order and subjects of the Lectures were as follows:

I. Monday, Feb. 19.—Strategy and Grand Tactics. Capt. C. W. Raymond, U. S. Engineers.
II. Friday, " 23.—Logistics. 1st Lieut John Millis, U. S. Engineers.
III. Monday, " 26.—Small Arms and their influence on Tactics. 1st Lieut. Eugene Griffin, U. S. Engineers.
IV. Friday, Mar. 2.—Artillery. Capt. J. C. Mallery, U. S. Engineers.
V. Monday, " 5.—Fortification. Capt. J. H. Willard, U. S. Engineers.
VI. Friday, " 9.—Sea Coast Defense. General H. L. Abbott, U. S. Engineers.

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Additions to the Department of Dynamical Engineering.

During the past year a number of important additions have been made to the Department of Dynamical Engineering, through the generosity of the business firms and gentlemen named below.

It is believed that the study of these machines and drawings has been and will be of great importance in making the students familiar not only with standard machinery, but particularly as giving practical illustration of how the details of construction are worked out by our most experienced engineers; for the student in the designing of a machine must be guided to a great extent by the unwritten experience of others.

While the usefulness of a machine can not be measured by its money value, when possible the market or list price is noted. For the many beautiful photographs and drawings none of course can be given.

F. R. Pickering & Co., Portland, Ct. A "1½ in" Pickering Governor, finely finished with side cut away to show the construction and operation of valve. $31.50.

The Perpetual Tension Belt Co., New York. Samples of flexible wire belting.

The Yale Lock Manufacturing Co., Stamford, Ct. A one-ton Weston Differential Pulley Block with weight, a standard machine. $30.00.

W. & B. Douglas, Middletown, Ct. A "No. 2" brass Hydraulic Ram with glass air chamber to show operation of valves. $20.00.

The Tanite Co., Stroudsburg, Pa. A "No. 3" Emery Grinding Machine, complete with counter-shaft, cone pulley and hangers; together with a set of nine 18-in. emery wheels of various grades and shapes. $239.00.

The Crosby Steam Valve and Gauge Co., Boston. A fine "Crosby" Indicator, nickel plated and complete in every respect. $90.00.

The American Steam Gauge Co., Boston. A fine "Thompson Improved Indicator," nickel plated and complete in every respect. Also an "Amsler Polar Planimeter" for measuring the area of indicator cards and a pantograph for reducing the motion of engine; in all $130.00. Also from the same firm, two nickel plated Bourdon Spring Gauges, one steam, the other vacuum, and two

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nickel plated Lane's Improved Spring Gauges, with a portion of face cut away to show interior construction; in all $62.00.

The Deane Steam Pump Co., Holyoke, Mass. A beautifully finished "No. 3" Deane Steam Pump, with portions cut away to show the details of construction and arrangement of valves. $225.00.

Ed. Dewey & Co., Boston. A "2-in." Waters Engine Governor, with automatic safety-stop attachment. $32.00.

Hancock Inspirator Co., Boston. Two inspirators or injectors finely mounted, one in section showing the construction and operation of valves, the other complete. $40.00.

The Knowles Steam Pump Works, New York. A "No. 1" Steam Pump beautifully finished and complete in every respect. $125.00.

Foskett & Bishop, New Haven. A very complete set of Steam Pipe Fittings, with sections of pipe, numbering in all 116 pieces. $40.00.

The Eaton, Cole & Burnham Co., Bridgeport. Sets of nickel plated Globe Valves, Check Valves, Angle Valves, and Plug Cocks, including all sizes up to 2-in. diameter. These valves were exhibited by the Company at the Centennial Exposition in 1876, and are finely finished. $103.00.

Reynolds & Co., New Haven. A complete set of Bolts, Nuts, Machine and Lag Screws, up to $\frac{3}{4}$ in. diameter. $15.00.

Mr. Henry Tyler, New Haven. Small Steam Whistle.

McLagon & Farnsworth, New Haven. Samples of Pig Iron and Moulding Sand.

Henry R. Worthington & Co., New York. In addition to the Steam Pump already acknowledged, a fine water meter, and three large framed photographs of pumping machinery.

Colt's Patent Fire Arms Manufacturing Co., Hartford. A set of Baxter Engine Piston Springs.

Messrs. Schutte & Goehring, Philadelphia. A "No. 3" Exhaust Steam induction Condenser, beautifully finished and mounted for exhibition. $80.00.

Mr. Frank Bigelow, New Haven. A Four Horse Power vertical Steam Engine, well proportioned and complete in every respect. $150.00.

Naylor & Co., Boston, through Messrs. Ensign & Son of New Haven. A fine case of Compressed Steel Shafting.

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The Deane Steam Pump Co., Holyoke, Mass. A set of twelve large framed photographs of Pumping Machinery.

The Bureau of Steam Engineering, Washington. A set of drawings of Launch Engines and Boilers built in the Government Yards; also large lithographs of Compound Engines designed for Monitors.

The Pratt & Whitney Co., Hartford. Drawings of Bench Drilling Machine.

Wm. A. Harris, Providence, R. I. Large framed photograph of Corliss Engine.

The Providence Steam Engine Co., Providence. Large framed photograph of the Improved Green Engine.

Wm. Contie & Son, Troy, N. Y. Two large framed photographs of Compound Engines.

Willimantic Linen Co., Willimantic, Ct. Large framed photograph of Porter Allen Engines, and also lithograph of their new Mill.

Wm. Clark & Co., Pittsfield, Mass. Large framed photographs of Rotary Pumps.

The Silsby Manufacturing Co., Seneca Falls, N. Y. Framed photograph of Silsby Steam Fire Engine.

The Babcox & Wilcox Co., New York. Framed lithograph of Root Boilers.

Davidson Steam Pump Co., Brooklyn. Large framed photograph of Compound Condensing Pumping Engine.

The Portland Co., Portland, Me. Large photographs of Marine Engine and Fishing Steamer.

E. P. Allis & Co., Milwaukee, Wis. Large photograph of Compound Pumping Engine.

Watts, Campbell & Co., Newark, N. J. Large framed photograph of Corliss Engine.

In addition to the above a large number of valuable trade circulars and book catalogues have been received, which as soon as practicable will be placed on file and indexed.

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Additions to the Zoological Collections.

A. E. Verrill, Curator; J. H. Emerton, Assistant.

The exploration of the sea-bottom beneath the Gulf Stream, off the southern coast of New England, which the U. S. Fish Commission undertook in 1880, was continued during the summer vacation, by means of the new steamer Albatross, Lieut. Z. L. Tanner commanding. The headquarters were at Wood's Holl, Mass., as in 1881 and 1882. The curator, as heretofore, had general charge of the invertebrata, and the party of naturalists was organized nearly as in the previous years. The collections obtained last year were quite as large and even more valuable than in the three previous seasons. The invertebrata, as usual, were sent to our museum for determination and distribution. When this is done, series are deposited in the Museum. During the present year, large numbers of those that have been worked up have been labeled and sent to the National Museum, at Washington.

The curator has published during the year, in the Bulletin of the Museum of Comparative Zoology, a report on the deep-water Anthozoa taken off our coast and in the West Indies by Mr. A. Agassiz, on the Blake, and by the Fish Commission, illustrated by eight plates; and others on the deep-sea Cephalopods dredged by the Blake in the West Indies, and on the Pacific coast Cephalopods, illustrated by several plates.

Professor S. I. Smith has taken charge of the Crustacea in the Museum. He has published in the Proceedings of the National Museum a lengthy illustrated paper on the deep-water Crustacea taken by the Fish Hawk, in 1880 to 1882; and others on the Crustacea of Labrador.

Mr. J. H. Emerton, besides making most of the drawings for the reports named above, as well as for others in progress, has prepared for publication in the Trans. Conn. Academy, vol. vi, a monograph of the New England Spiders of the family Epeiridæ, illustrated by eight plates.

Mr. Emerton has also finished the life-sized restoration of one of the gigantic Cephalopods of Newfoundland (*Architeuthis princeps*), now on exhibition in the Museum. He has, also, completed two duplicates of this: one for the Museum of Comparative Zoology, and one for the National Museum, and has made a

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large model of the great California Octopus (*O. punctatus*), for the National Museum. The latter and one of the models of *Architeuthis* were sent to the Fishery Exhibit, in London. Mr. Emerton is now making two additional copies of the Octopus model: one for our Museum, and one for the Museum of Comparative Zoology. In the making of these models he has been assisted by Mr. William Palmer, of Washington, Mr. A. Baldwin, and others. A cast of the Gulf Stream dolphin (*Delphinus delphis*) has also been finished and put on exhibition by Mr. Emerton.

Miss K. J. Bush has been engaged in labeling and cataloguing the large collections of shells made by the U. S. Fish Commission during the past twelve years, and in other similar work. She has also prepared a report on the shells and Echinoderms of Labrador, illustrated by a plate drawn by Mr. Emerton. This has been printed in the Proceedings of the National Museum.

Mr. Oscar Harger has published in the Bulletin of the Museum of Comparative Zoology, a report on the Isopods of the Blake Expeditions, illustrated by several plates.

The collection of fishes obtained by the late Professor F. H. Bradley, at Panama and other localities on the west coast of America, has been worked up by Messrs. D. F. Jordan and C. H. Gilbert, who have published a catalogue of them in the Proceedings of the National Museum. The fishes of the Gulf of Mexico and S. America, have also been sent to Mr. Gilbert.

In addition to the large collections from the U. S. Fish Commission, the following have been received:

Milton W. Jacobs. Squilla, New Haven; Green Callosoma.

T. S. Gold. Pomotis, from Naugatuck River; lice of cattle.

National Museum. A new species of Octopus (*O. bimaculatus V.*) from San Diego, Cal.; shrimp from New Orleans.

Horace Bowman. Eel-pout (*Zoarces*) from Long Island Sound.

Prof. D. C. Eaton. Three species of land shells from Cuba, coll. Dr. A. P. Garber.

C. F. Graves. Parasitic crustacean.

J. A. Allen (S. S. S.). Fresh-water shells from Nova Scotia.

E. H. Hubbard, Woodmont. Actinia.

W. B. H. Trowbridge. Several eels, (*Ophisurus*) and a fine *Pentacrinus*, in alcohol, from Barbados.

Chas. E. Bowles. Puffing adders, East Rock.

M. Schultheiss. Wasp nest, New Haven.

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T. Bary. Egg of snake, New Haven.

Henry A. Barnes, New Haven. Nest of Maranta Bee.

Museum of Comparative Zoology. A valuable series of deep-sea Ophiurans and Echini, from the Blake Expeditions. Also a series of duplicates of the Blake Crustacea.

By purchase. Four young foxes with their mother. From North Branford.

Two seals (*Phoca vitulina*) taken at Guilford in April.

A large *Octopus vulgaris* from Hamilton Inlet, Bermuda. Said to have crawled upon the deck of the yacht Peerless.

Anniversary.

The Exercises of the Graduating Class were held in North Sheffield Hall on the evening of Tuesday, June 28, 1883. The candidates for degrees with the subjects of the graduation theses of the Bachelors of Philosophy are given in the following schedule. Those marked with an asterisk read theses in the evening.

Bachelors of Philosophy. (45).

*John Alpheus Allen (Chemistry), *New Haven.* On the Phosphates of Manganese produced by reactions of Fused Compounds.

*John Bartholomew (Dynamic Engineering), *Guilford.* On the Development of Electrical Science.

*Frederick Elijah Beach (Dynamic Engineering), *New Haven.* On the Storage of Electrical Energy.

*Charles Milo Carpenter (Civil Engineering), *Madison, Wisc.* On the Lamberton Street Iron Bridge over the N. Y., N. H. & H. R. R.

Samuel Myron Chase (Select), *Chicago, Ill.* On the Archæan and Paleozoic Time.

*Edward Bradford Dench (Biology), *Bridgeport.* On the Anatomy and Histology of the Ear.

Edward Peers Eastwick, Jr. (Dynamic Engineering), *New York City.* On the Transmission of Power to Great Distances.

*Horatio Southworth Frazer (Chemistry), *Holyoke, Mass.* On the Bleaching Processes used in Paper Manufacture.

James Lyman (Dynamic Engineering), *Middlefield.* On the Strength of Iron and Steel with reference to Bridge Construction.

*Henry Curtis Nutt, Jr. (Civil Engineering), *Boston, Mass.* On the Construction of Suspension Bridges.

*Charles Locke Scudder, B.A. (Biology), *Great Barrington, Mass.* On the Origin and Nature of the Proteolytic Ferment of the Gastric Glands of the Rabbit.

*Robert Hawthorne Wylie (Biology), *Chester, S. C.* On the Germ Theory of Disease.

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PAUL WHITIN ABBOTT (Select), *New Haven.* On the Policy of Gladstone in regard to Ireland.

BENJAMIN SAFFORD BARROWS (Biology), *Hartford.* On the Development of the Vertebral Column of the Chick.

GEORGE ANDREW BARROWS (Select), *Philadelphia, Pa.* On the Treatment of the Supernatural by Bulwer in his Novels.

FREDERICK ROBINSON BARTLETT (Chemistry), *Freeport, Ill.* On the Methods of Determining Silicon in Pig Iron.

FREDERICK TRUMAN BRADLEY (Chemistry), *New Haven.* On Commercial Fertilizers, their Use and Manufacture.

CHARLES SUMNER BROWN (Dynamic Engineering), *Easthampton.* On the Development of Bolt and Screw Cutting Machinery.

HORACE RAYMOND CARPENTER (Civil Engineering), *Afton, N. Y.* On Derrick Cranes.

HARRY NELSON COVELL (Dynamic Engineering), *Stamford.* On the Holly System of Steam Heating.

WAYNE DARLINGTON (Dynamic Engineering), *Westchester, Pa.* On Light Iron Bridges.

HENRY KELSEY DEVEREUX (Select), *Cleveland, O.* On the United States Life Saving Service.

ROBERT OGDEN DUBOIS (Biology), *New Haven.* On the Histology of the Tea Leaf and the Detection of its Adulterations by the Microscope.

CHARLES LOCKWOOD GOLD (Agriculture, *West Cornwall.* On the Preparation of Maple Sugar.

CHARLES STEWART HALL (Civil Engineering), *Warren, O.* On the Construction of the Foundations of the Piers of the St. Louis and Illinois Bridge.

GEORGE VANCE HARPER (Dynamic Engineering), *Denver, Col.* On Structures of Iron and Steel.

WILLIAM HARPER (Select), *Shippensburg, Pa.* On the Postal Savings Bank System.

ALLEN HUBBARD (Dynamic Engineering), *Westfield, Mass.* On the Engine Lathe.

JOHN ELMER LOCKWOOD (Select), *Stamford.* On the Early History of the English Tongue.

WILLIAM ELLISON LOCKWOOD (Biology), *Stamford.* On the Anatomy and Histology of the Mammalian Eye.

JOHN HENRY MANN (Dynamic Engineering), *Utica, N. Y.* Design for a Vertical Engine with Special Valve Gear for Reversing.

JOHN EDMUND NEWELL (Chemistry), *Chicago, Ill.* On the Methods of Determining Manganese in Iron and Steel.

GEORGE SHIPMAN PAYSON (Dynamic Engineering), *Chicago, Ill.* On the Manufacture of Iron.

EDWARD WELLS PENFIELD (Dynamic Engineering), *Chicago, Ill.* On Steel.

DAVID MURDOCH PRATT (Select), *Elmira, N. Y.* On the National Banking System.

WILLIE SHERMAN RANDALL (Biology), *Birmingham.* On the Anatomy and Histology of the Kidney of the Cat.

ALBERT WILLIAM ROBERT (Chemistry), *New York City.* On Pararzoxybenzanilide.

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CHARLES LANSING SAYRE (Chemistry), *Utica, N. Y.* On the Electrolytic Depositions of Antimony and other Metals.

HORACE LEE SIMPSON (Biology). *Pensacola, Fla.* On the Anatomy and Histology of the Eye of the Common Fowl.

EBENEZER HUBBARD SKINNER (Select), *Escambia, Fla.* On the Protection of the Iron Industries of the United States.

JOSEPH ALLEN SKINNER (Dynamic Engineering), *Holyoke, Mass.* On the Power Loom.

EDWARD IRVING STONE (Select), *Bethlehem.* A Geological Review of the Age of Man.

JOHN EDWARDS STRYKER (Dynamic Engineering), *Catskill, N. Y.* On the Theory of Draught in Chimneys.

CHUAN LOK WING (Civil Engineering), *Canton, China.* On the Musconeteong Tunnel.

ALEXANDER WURTS (Dynamic Engineering), *New Haven.* On the Conservation of Energy.

PRIZES.

At the Anniversary Exercises on June 28th the following prizes were announced:

CLASS OF 1883.

For excellence in Civil Engineering, HENRY C. NUTT, Jr.

For excellence in Dynamic Engineering, JOHN BARTHOLOMEW, and FREDERICK E. BEACH.

For excellence in German, JOHN BARTHOLOMEW.

CLASS OF 1884.

For excellence in the Mathematics of Junior Year, CHARLES P. FARQUHAR; with honorable mention of EDWIN M. HERR, and WILLIAM W. NICHOLS.

CLASS OF 1885.

For excellence in all the Studies of Freshman Year, JOHN V. HANNA; with honorable mention of CHARLES D. MCCANDLISS.

For excellence in German, LOUIS M. SCHMIDT.

For excellence in Mathematics, JOHN V. HANNA.

For excellence in Physics, JOHN V. HANNA.

For excellence in Chemistry, JAMES J. MORGAN.

For excellence in Mechanical Drawing, JOHN J. FLATHER, and SYDNEY A. REEVE.

For excellence in English Composition—1st Prizes, GRENVILLE F. ALLEN, CHARLES D. MCCANDLISS; 2d Prizes, ROBERT N. BRAGE, WALLACE S. CLARK, JOHN E. HILL, LOUIS M. SCHMIDT; 3d Prizes, MERRITT M. CLARK, JOHN J. FLATHER, IRVING C. GLADWIN, JOHN V. HANNA.

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PROGRAMME OF STUDIES,

AND

CATALOGUE,

FOR THE COLLEGE YEAR 1883-84.

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CALENDAR.

1883.		
13 Sept.	Thursday,	First Term begins.
20 Dec.	Thursday,	First Term ends.
1884.		**Winter Vacation of three weeks.**
10 Jan.	Thursday,	Second Term begins.
9 April,	Wednesday,	Spring Recess begins.
16 April,	Wednesday,	Spring Recess ends.
24 June,	Tuesday,	Meeting of Appointing Board.
24 June,	Tuesday,	Anniversary.
25 June,	Wednesday,	Commencement.
26, 27, 28 June	Thursday, Friday, Sat.,	Examination for Admission.
		Summer Vacation of twelve weeks.
16, 17 Sept.	Tues., Wedn.,	Examination for Admission.
18 Sept.	Thursday,	First Term begins.
18 Dec.	Thursday,	First Term ends.

ABBREVIATIONS.

S. H.	Sheffield Hall.
N. S. H.	North Sheffield Hall.
TR.	Treasury Building.
D.	Durfee College.
F.	Farnam College.
E.	East Divinity Hall.
W.	West Divinity Hall.
P. M.	Peabody Museum.
A.	Absent on leave.

In the buildings belonging to the Sheffield Scientific School, the rooms numbered from 1 to 21 are in Sheffield Hall; from 26 to 58 in North Sheffield Hall.

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Chairman and Executive Officer.

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ARRANGED IN THE ORDER OF THEIR GRADUATION.

———— — ————,
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Botany. (41 N. S. H.) 70 Sachem st.

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Dynamical Engineering (HIGGIN *Professor.*) (45 N. S. H.) 258 Bradley st.

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Free Hand Drawing. 8 Art School.

FREDERICK R. HONEY,
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Kinematics and Machine Design. (45 N. S. H.) 19 Warren pl.

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Analytical Chemistry. 138 College st.

CHARLES HILDEBRAND,
Mathematics. 747 State st.

SAMUEL L. PENFIELD,
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ALTON W. LEIGHTON,
Drawing. 129 College st.

HAROLD B. NYE,
Analytical Chemistry. 91 W.

LOUIS V. PIRSSON,
Analytical Chemistry. 53 Prospect st.

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ANTON PFEIFER, 55 Lock street.

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GEORGE W. STODDARD, 82 Mansfield street.

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John Bartholomew, PH.B.	*Guilford*	91 Olive st.
Arnold Guyot Dana, B.A.	*New Haven*	24 Hillhouse av.
George Heber Graves, B.A.	*New Haven*	61 Grove st.
Chester Wolcott Lyman, B.A.	*New Haven*	88 Trumbull st.
Thomas Burr Osborne, B.A.	*New Haven*	156 Crown st.
Louis Valentine Pirsson, PH.B.	*New York City*	4 Mansfield st.
Samuel Lucius Penfield, PH.B.	*Catskill, N. Y.*	14 S. M.
Herbert Eugene Smith, PH.B., M.D. Univ. of Pa.	*New Haven*	76 Howe st.
Franklin Eldred Worcester, A.B.	*New York City,*	72 W. D.

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SENIOR CLASS

Gustavo Alfonso	*New York City*	36 Elm st.
Elwood Harvey Allcutt	*Kansas City, Mo.*	101 w.
Laurence Vincent Benét	*Washington, D. C.*	18 Trumbull st.
Edward Blake	*New Haven*	107 w.
Clarence Russell Britton	*Cleveland, O.*	36 Elm st.
Chauncey Rea Burr	*Portland, Me.*	119 w.
Albert Park Campbell	*New Haven*	28 York sq.
Herbert DeWitt Carrington	*New Haven*	527 Chapel st.
William Brainard Coit	*New London*	36 Elm st.
Clifford Laurence Colton	*Canton*	65 Grove st.
Louis Edward Cooper	*Ansonia*	94 York sq.
George Wyckoff Cummins	*Vienna, N. Y.*	94 York sq.
Charles Percival Farquhar	*York, Pa.*	289 York st.
Arthur Bixby Ferguson	*New Haven*	30 Crown st.
Davenport Galbraith	*Erie, Pa.*	36 Elm st.
Morgan Augustus Guinnip	*Washington, D. C.*	116 Crown st.
Calvin Linsley Harrison	*New Haven*	94 Wooster st.
John Bell Hatcher	*Cooper, Iowa*	12 Elm st.
Samuel Brown Hawley	*Yonkers, N. Y.*	43 College st.
Edwin Musser Herr	*Denver, Col.*	289 York st.
James Henry Jennings	*Redding*	17 College st.
Henry Clay Johnson	*Rome, Ga.*	201 Chapel st.
Thomas Crossley Johnson	*New Haven*	80 LaFayette st.
Edson Keith, Jr.	*Chicago, Ill.*	36 Elm st.
Duane Judson Kelsey	*Killingworth*	266 York st.
Albert Lucas	*Philadelphia, Pa.*	43 College st.
James Minor Maghee	*Evansville, Ind.*	65 York sq.
Luther James Martin	*Norwich*	361 Elm st.
Seyton Howard Martin	*Clifton, N. Y.*	71 w.
George Edgar Moulthrop	*New Haven*	253 North Front st.
William Wallace Nichols	*Manitou Springs, Col.*	289 York st.
Albert Anderson Noye	*Buffalo, N. Y.*	99 Wall st.
Herbert Lincoln Noyes	*New Haven*	74 High st.
Joseph Powell, Jr.	*Towanda, Pa.*	43 College st.
Joseph Warren Rogers, Jr.	*Scarborough, N. Y.*	73 Mansfield st.
Walter Allen Sadd	*South Windsor*	159 Temple st.
William Godfrey Sage	*Chicago, Ill.*	65 York sq.
Russell Sargent	*New Haven*	51 Elm st.
Clarence Wellington Sheldon	*Brooklyn, N. Y.*	36 Elm st.
William Tuttle Shepard	*Bristol*	17 College st.
John Prentice Terry	*Brooklyn, N. Y.*	121 Park st.
Chester Thorne	*Millbrook, N. Y.*	101 w.
James Henry Warner	*Steubenville, O.*	63 Prospect st.
Elmore Abram Willets	*Belmont, N. Y.*	43 College st.
Andrew Lincoln Winton	*Bridgeport*	63 Prospect st.

SENIORS, 45

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JUNIOR CLASS

Arthur Bronson Adams	*New Haven*	120 St. John st.
Grenville French Allen	*New Haven*	197 Temple st.
Philip VanWyck Anderson	*Sing Sing, N. Y.*	68 w.
James Arthur Atwood	*Wauregan*	43 College st.
John Frank Babcock	*Elmira, N. Y.*	36 Elm st.
Paul Daily Bernard	*Brooklyn, N. Y.*	68 w.
Clarence Blakeslee	*New Haven*	316 George st.
Robert Neill Brace	*Dobbs Ferry, N. Y.*	57 w.
Fred Spencer Bullene	*Kansas City, Mo.*	36 Elm st.
Richard Morton Bushnell, Jr.	*Saybrook*	225 Orange st.
Merritt Mead Clark	*Bedford, N. Y.*	177 Temple st.
Wallace Sherman Clark	*New York City*	226 George st.
Arthur Chandler Coates	*Kansas City, Mo.*	36 Elm st.
Arthur Carrington Cowles	*Wallingford*	136 College st.
William Ledlie Culbert	*Brooklyn, N. Y.*	57 w.
John Joseph Flather	*Bridgeport*	295 York st.
William Holt Gale	*New York City*	324 Prospect st.
Irving Cook Gladwin	*Sherburne, N. Y.*	59 w.
Jacob Phillip Goodhart	*New Haven*	107 Court st.
Charles Lord Griffith	*San Francisco, Cal.*	36 Elm st.
John Venable Hanna	*Kansas City, Mo.*	58 w.
John Ethan Hill	*Mystic Bridge*	314 York st.
David Leavitt Hough	*Fort Wayne, Ind.*	59 w.
Percy Jackson	*Belleville, N. J.*	203 York st.
Edwin Young Judd	*Hartford*	86 w.
Amos William Kimball	*Portland, Oregon*	43 College st.
Harry D. Kohn	*Chicago, Ill.*	63 w.
Ira Lamb	*Franklin*	157 Orange st.
Percy Lyford Lang	*Waverly, N. Y.*	43 Chapel st.
Charles Pond McAvoy	*Chicago, Ill.*	43 College st.
Charles Dickerman McCandliss	*Philadelphia, Pa.*	58 w.
William Adair McDowell	*Lexington, Ky.*	43 College st.
Daniel William Maher	*New Haven*	129 Spring st.
Daniel Delevan Mangam, Jr.	*Sing Sing, N. Y.*	43 College st.
William Edward Martin	*Allentown, Pa.*	167 Temple st.
Edwin Alexander Meredith	*Xenia, O.*	65 York sq.
Deane Miller	*New Rochelle, N. Y.*	226 George st.
Herbert Lincoln Mitchell	*New Haven*	52 Insurance B'ld'g.
James Jacob Morgan	*New Haven*	470 Elm st.
William Alpheus Nettleton	*Kansas City, Mo.*	124 w.
Truman Handy Newberry	*Detroit, Mich.*	43 College st.
Isaac Norris, 3d	*Philadelphia, Pa.*	77 w.
George Washington Norton, Jr.	*Louisville, Ky.*	124 w.
Henry Oliver	*Pittsburgh, Pa.*	106 w.
John Cunningham Oliver	*Pittsburgh, Pa.*	106 w.
Abbott Chandler Page	*Fair Haven*	South Quinnipiac st.
Willis LaFayette Perkins	*Portland, Me.*	203 York st.

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Royal Watson Pinney	*Derby*	167 Temple st.
Daniel Tuthill Pratt	*Elmira, N. Y.*	36 Elm st.
Sidney Armour Reeve	*Dayton, O.*	59 Grove st.
Willard Crawford Reid	*Lakeville*	74 High st.
John Rice	*Pottstown, Pa.*	43 College st.
Charles Thomas Richardson	*Hornellsville, N. Y.*	43 College st.
William Todd Ross	*Belfast, Me.*	60 W.
Charles Gideon Rupert	*New Market, Va.*	111 Dwight st.
Frank Elbert Sands	*New Haven*	119 Dwight st.
Louis Milton Schmidt	*New Britain*	59 Grove st.
James Alward Seymour	*Auburn, N. Y.*	36 Elm st.
Murray Shipley, Jr.	*Cincinnati, O.*	109 Elm st.
Joseph Godfrey Snydacker	*Chicago, Ill.*	63 W.
Frank Jerome Stevens	*New Haven*	7 Wooster pl.
William VanSchoonhoven Thorne	*New York City*	133 College st.
Henry Lee Townsend	*New York City*	88 W.
Curtiss Chauncey Turner	*Omaha, Nebr.*	60 W.
George Elliot Verrill	*New Haven*	86 Whalley av.
Frederick Brewster Wheeler	*Monroe*	175 Temple st.
Henry Howard Whitehouse	*Hartford*	167 Temple st.
Willis Stoughton Williams	*Minneapolis, Minn.*	65 York sq.
Winslow Tracy Williams	*Norwich*	71 W.
Edward Simpson Wilson	*New York City*	119 W.
Clarence Henry Wood	*Morristown, N. J.*	43 College st.
Benjamin Elizur Wright	*Cromwell*	91 W.

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FRESHMAN CLASS

William Allender	*New London*	134 College st.
Gilbert Lincoln Husted Arnold	*Stamford*	607 Elm st.
William Wallace Atterbury	*Detroit, Mich.*	55 Prospect st.
Nathan Edward Ayer	*Bangor, Me.*	Church st.
Silas Warren Bartlett	*New Haven*	675 Chapel st.
Emil Baumgarten	*New York City*	63 Prospect st.
Henry William Blake	*New Haven*	149 Temple st.
John Marvin Blakeley	*St. Paul, Minn.*	251 Church st.
Howard Cone Bolton	*Cleveland, O.*	55 W.
Percival Ranney Bolton	*Cleveland, O.*	55 W.
Louis Whitford Bond	*New York City*	61 W.
Thomas Stoddard Bronson	*New Haven*	684 Chapel st.
Harry Lockwood Burns	*Milford*	57 Prospect st.
Lewis Emerson Cadwell	*New Haven*	106 Liberty st.
Fred. Eaton Case	*Detroit, Mich.*	76 Mansfield st.
Theodore Newton Case	*Hartford*	87 Trumbull st.
John Chamberlain	*Kansas City, Mo.*	76 Mansfield st.
Lucian Thorp Chapman	*New York City*	156 Grove st.
George Frederick Converse	*New Haven*	158 Olive st.
Frederick William Darlington	*West Chester, Pa.*	105 Wall st.
Alexander Harrison Davis	*Watertown*	104 Wall st.
John Edwin Doane	*Chicago, Ill.*	92 W.
Joseph Osterman Dyer, Jr.	*Galveston, Texas*	31 Trumbull st.
Ansel Mills Easton	*Millbrae, Cal.*	215 York st.
Charles Francis Emerson	*Titusville, Pa.*	38 Elm st.
Harvey Farrington	*Croton, N. Y.*	64 High st.
Joseph Essex Fitzsimons	*Waterbury*	84 Dixwell av.
Robert Elder Forster	*Harrisburg, Pa.*	44 Elm st.
Charles Albert Fry	*Westville*	147 Bradley st.
Frederick Abbot Goodwin	*Rutland, Vt.*	82 Wall st.
William Washington Gordon, 3d	*Savannah, Ga.*	115 Elm st.
James Eugene Greenebaum	*Chicago, Ill.*	110 Olive st.
Everett Mason Grimes	*Oakland, Cal.*	161 Temple st.
Theodore Newell Haller	*Seattle, Wash. Terr.*	76 Mansfield st.
Harry Cloyd Hamill	*Georgetown, Col.*	161 Temple st.
David Neil Harper	*Shippensburgh, Pa.*	287 York st.
Frank Sperry Harrison	*New Haven*	18 Warren st.
Willis Benjamin Herr	*Denver, Col.*	287 York st.
Jay Russell Hickox	*South Britain*	270 Martin st.
William Brisbane Hickox	*Litchfield*	128 High st.
William Barlow Hill	*Greenfield Hill*	17 College st.
Abraham Lincoln Howes	*Black Rock*	63 Prospect st.
Marvin D. Hubbell	*New York City*	94 York sq.
William Evelyn Hutchings	*Louisville, Ky.*	163 Temple st.
Morison Thomas Hutchinson	*Brooklyn, N. Y.*	165 Temple st.
Abraham Lincoln Hyde	*New Haven*	179 Washington st.

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William David Johnson	*New Haven*	92 Rosette st.
Henry Bourne Joy	*Detroit, Mich.*	72 High st.
Thomas Coggeshall Knowles	*San Francisco, Cal.*	161 Temple st.
Harrie Sheldon Leonard	*Washington, D. C.*	8 Lock st.
Cornelius Fay Lynde	*Rock Island, Ill.*	237 Orange st.
Mahlon Henry Marlin	*New Haven*	178 George st.
Frederick Anderson Marsh	*Kansas City, Mo.*	109 Wall st.
Conrad Henry Matthiessen	*Cornwall, N. Y.*	155 Elm st.
Arthur Meeker	*Chicago, Ill.*	124 High st.
Edwin Frank Meyer	*Chicago, Ill.*	110 Olive st.
George Perkins Miller	*Utica, N. Y.*	163 Temple st.
Samuel Everett Oakes	*Washington, D. C.*	184 York st.
Henry White Patten	*North Haven*	17 Wooster pl.
George Eustis Potts	*Philadelphia, Pa.*	61 w.
James Frederick Prentiss	*Watertown, Wisc.*	44 Elm st.
William Acker Rice	*St. Paul, Minn.*	251 Church st.
Arthur Jones Richmond	*Providence, R. I.*	55 Trumbull st.
Samuel Bostwick Robbins	*Lakeville*	87 Trumbull st.
Reginald Ronalds	*New York City*	134 College st.
Alexander Holley Rudd	*Lakeville*	61 Grove st.
Henry Rustin	*Omaha, Nebr.*	New Haven House
Emanuel Frank Selz	*Chicago, Ill.*	110 Olive st.
Edwin Coupland Shaw	*Buffalo, N. Y.*	63 Prospect st.
Alfred Edgar Siviter	*West Stratford*	91 w.
Edward Arthur Smith	*Middletown*	61 Prospect st.
George Howard Smith	*Canajoharie, N. Y.*	167 Temple st.
William Sanders Tevis	*San Francisco, Cal.*	44 Elm st.
John Metcalfe Thomas	*New York City*	134 College st.
Louis Denio Tourtellot	*Utica, N. Y.*	124 High st.
Calvert Townley	*Cincinnati, O.*	192 York st.
George Pollok Devereux Townsend	*Middletown*	252 York st.
Thomas Brodhead VanBuren, Jr.	*Englewood, N. J.*	55 Trumbull st.
Henry Hayes Wadsworth	*Glencoe, Minn.*	Allingtown
James Edward Warnock	*Atlanta, Ga.*	128 York st.
John Willard Willard	*New York City*	109 Elm st.
Charles Willcox	*Omaha, Nebr.*	163 Temple st.
Rockwell Amasa Williams	*Canterbury*	104 Wall st.
Robert McKnight Woods	*New Haven*	210 George st.

FRESHMEN, 84

SPECIAL STUDENTS NOT CANDIDATES FOR A DEGREE.

Louis Ross Alberger	*Buffalo, N. Y.*	292 Ferry st.
Francis Lewis Sperry	*Tallmadge, O.*	146 College st.
James Prior Wood	*West Haven*	2 Church st.

SPECIAL STUDENTS, 3

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SUMMARY.

Graduates,	9
Seniors,	45
Juniors,	72
Freshmen,	84
Special,	3
Total,	213

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SHEFFIELD SCIENTIFIC SCHOOL.

I.

OBJECTS.

THE SHEFFIELD SCIENTIFIC SCHOOL is devoted to instruction and researches in the mathematical, physical, and natural sciences, with reference to the promotion and diffusion of science, and also to the preparation of young men for such pursuits as require especial proficiency in these departments of learning. It is one of the Departments of Yale College, like the law, medical, theological, and art schools, having its separate funds, buildings, teachers, and regulations, but governed by the Corporation of Yale College, which appoints the professors and confers the degrees. It is, in part, analogous to the academic department, or classical college, and, in part, to the professional schools.

The instruction is intended for two classes of students:—

I. Graduates of this or of other Colleges, and other persons qualified for advanced or special scientific study.

II. Undergraduates who desire a training chiefly mathematical and scientific, in less part linguistic and literary, for higher scientific studies, or for various other occupations to which such training is suited.

II.

HISTORY AND ORGANIZATION.

The School was commenced in 1847. In 1860, a convenient building and a considerable endowment were given by Joseph E. Sheffield, Esq., of New Haven, whose name at the repeated request of the Corporation of Yale College, was afterward attached to the foundation. Mr. Sheffield afterward frequently and munificently increased his original gifts.

In 1863, by an act of the Connecticut Legislature, the national

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grant for the promotion of scientific education (under the congressional enactment of July, 1862) was given to this department of Yale College. Since that time, and especially since the autumn of 1869, numerous liberal gifts have been received from the citizens of New Haven, and from other gentlemen in Connecticut, New York, and St. Louis, for the endowment of the School, and the increase of its collections.

The action of the State led to the designation by law of a State Board of Visitors, consisting of the Governor, Lieutenant-Governor, three senior Senators, and the Secretary of the State Board of Education: and this Board, with the Secretary of the Scientific School, is also the Board for the appointment of students to hold the State scholarships.

The Governing Board consists of the President of Yale College and the Professors who are permanently attached to the School. There are several other instructors associated with them, a part of whom are connected with other departments of the College.

III.

BUILDINGS AND APPARATUS.

The two buildings in which the work of instruction in the Scientific School is mainly carried on are called Sheffield Hall and North Sheffield Hall; but instruction in Mineralogy, Geology, and Biology, including Zoölogy and Comparative Anatomy, is now given entirely in the Peabody Museum. These halls contain a large number of recitation and lecture rooms, a hall for public assemblies and lectures, chemical and Metallurgical laboratories, a photographical room, an astronomical observatory, museums, a library and reading room, besides studies for some of the professors, where their private technical libraries are kept.

The following is a summary statement of the collections belonging to the School.

1. Laboratories and Apparatus in Chemistry, Metallurgy, Physics, Photography, and Zoölogy.
2. Metallurgical Museum of Ores, Furnace Products, etc.
3. Agricultural Museum of Soils, Fertilizers, useful and injurious insects, etc.
4. Collections in Zoölogy.
5. Astronomical Observatory, with an equatorial telescope by Clark and Sons of Cambridge, a meridian circle, etc.
6. A Collection of Mechanical Apparatus, constituting the "Collier Cabinet."

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7. Models in Architecture, Geometrical Drawing, Civil Engineering, Topographical Engineering and Mechanics; diagrams adapted to public lectures; instruments for field practice.

8. Maps and Charts, topographical, hydrographical, geological, etc.

The herbarium of Professor Brewer, and the astronomical instruments of Professor Lyman, are deposited in the buildings. Professor Eaton's herbarium, near at hand, is freely accessible. Students also have access to the various laboratories and collections in Natural Science in the Peabody Museum.

Students are also admitted, under varying conditions, to the College and Society libraries, the College Reading Room, the School of the Fine Arts, and the Gymnasium.

IV.

THE LIBRARY.

The special technical library of the Scientific School consists of about five thousand volumes. Included in this is the "Hillhouse Mathematical Library" of twenty-four hundred volumes, collected during a long series of years by Dr. William Hillhouse, and in 1870 purchased and presented to the Institution by Mr. Sheffield. A catalogue of this collection forms a supplement to the Annual Report of the Governing Board for 1870. All the prominent scientific journals of this country and of Europe, together with the proceedings of foreign academies, and scientific societies, can be found either in this library or in the College Library to which students have access.

V.

INSTRUCTION FOR GRADUATE AND SPECIAL STUDENTS.

Persons who have gone through undergraduate courses of study, here or elsewhere, may avail themselves of the facilities of the School for more special professional training in the physical sciences and their applications, gaining in one, two, or three years the degree of Bachelor of Philosophy, or, in two additional years of Engineering study, that of Civil Engineer, or of Dynamic Engineer.

Or, engaging in studies of a less exclusively technical character, they may become candidates for the degree of Doctor of Philosophy. The instruction in such cases will be adapted to the particular needs and capacities of each student, and may be combined

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with that given by the graduate instructors in other departments of the University. This degree is conferred upon those who, having already taken a Bachelor's degree, engage as students in the Department of Philosophy and the Arts for not less than two years in assiduous and successful study. It is not given upon examination to those whose studies are pursued elsewhere. The requirements for it will in some cases exact of the student more than two years of post-graduate labor; so, especially, wherever the course of undergraduate study has been, as in the Scientific School, of less than four years. The candidate must pass a satisfactory final examination, and present a thesis giving evidence of high attainment in the branches of knowledge to which he has attended. A good knowledge of Latin, German and French will be required in all cases, unless for some exceptional reason, the candidate be excused by the Faculty. The graduating fee is ten dollars.

Subjects likely to receive special attention are suggested as follows:

Professor LYMAN, in the use of meridional and other astronomical instruments.

Professor DUBOIS, in the principles of thermodynamics, and utilization of heat as a source of power.

Professor BRUSH, in the analysis and determination of mineral species, and in descriptive mineralogy.

Professor JOHNSON, in theoretical, analytical, and agricultural chemistry.

Professor BREWER, in agriculture and forest culture, in the use of the miscroscope, and in physical geography.

Professor CLARK, in definite integrals, differential equations, analytical mechanics, the theory of numerical approximation, with the method of least squares.

Professor EATON, in structural and systematic botany, with reference to both flowering and cryptogamous plants.

Professor ALLEN, in analytical chemistry, and in metallurgy.

Professor VERRILL, and Professor SMITH, in zoölogy and geology.

Professor CHITTENDEN, in physiological chemistry.

The same courses of study are open, for a longer or shorter time, to graduate students who do not desire to become candidates for a degree.

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Students who have taken the degree of Bachelor of Philosophy, may obtain the degree of CIVIL or of DYNAMIC ENGINEER at the end of two academical years, by pursuing the following higher course of study and professional training.

The course of study for the degree of CIVIL ENGINEER will comprise—

1. Higher Calculus. Higher Geometry. Theory of Numerical Operations.
2. Analytical Mechanics. Mechanics applied to Engineering.
3. A Course of Construction and Design. Projects.
4. Practical Astronomy, with use of instruments, computations, etc.

This course will occupy one year.

To secure the requisite amount of professional knowledge and practice, the candidate will be required to furnish a comprehensive report of the results of an examination into the existing condition of some special line of constructive art; or to present proper evidence that he has had actual charge in the field, for several months, of construction or surveying parties, or held some responsible position deemed equivalent to this.

An elaborate design must also be submitted of some projected work of construction, based upon exact data obtained from careful surveys made by the candidate, and comprising all the requisite calculations, and the necessary detailed drawings, and accompanied by full specifications of the work to be done, and the requirements to be met by the contractor.

The fee for this degree is five dollars.

The course of study for the degree of DYNAMIC ENGINEER will comprise—

1. Higher Calculus. Higher Geometry. Theory of Numerical Operations.
2. General Principles of Dynamics (Analytical Mechanics), including special application of these Principles to Dynamic problems.
3. Construction of Machines. Designs.
4. Preparation of theses on special subjects in Dynamic Engineering.

During the second year candidates will be permitted to employ such a portion of their time as may be deemed advisable or necessary in the examination of engineering works and manufacturing establishments, and may also have the privilege of entering upon professional practice, provided it is done with the knowledge and consent of the Professor of Dynamic Engineering, and under such circumstances as shall appear to him to be favorable to professional progress.

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An elaborate thesis on some professional subject, with an original design, or project, accompanied by proper working drawings, will be required at the end of the second year.

The fee for this degree is five dollars.

SPECIAL STUDENTS.—For the benefit of those who, being fully qualified, desire to pursue particular studies without reference to the obtaining of a degree, special or irregular students are received in most of the departments of the School: not, however, in the Select Course or in the Freshman Class.

It should be distinctly understood that these opportunities are not offered to persons who are incompetent to go on with regular courses, but are designed to aid those who, having received a sufficient preliminary education elsewhere, desire to increase their proficiency in special branches.

VI.

REQUIREMENTS FOR ADMISSION AND COURSES OF INSTRUCTION FOR UNDERGRADUATE STUDENTS.

TERMS OF ADMISSION.—Candidates must not be less than fifteen years of age, and must bring satisfactory testimonials of moral character from their former instructors or other responsible persons.

For admission to the Freshman Class the student must pass a thorough examination in the following subjects:

English—including grammar, spelling and composition. In grammar, Whitney's Essentials of English Grammar, or an equivalent.

History of the United States.

Geography.

Latin—(1) Simple exercises in translating English into Latin. (Smith's "*Principia Latina*," Part I, is named as indicating the nature and extent of this requirement, and an acquaintance with it will be required unless a satisfactory substitute is offered). (2) Cæsar—six books of the Gallic War, or their equivalent. (As advantageous substitutes for the last three books of Cæsar may be suggested three books of Vergil's Æneid, or a similar amount of Ovid.)

Arithmetic—Fundamental Operations. Least Common Multiple, Greatest Common Divisor, Common and Decimal Fractions, Denominate Numbers, including the Metric System of Weights and Measures; Percentages, including Interest, Discount, and Commission; Proportion, Extraction of the Square and Cube Roots.

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Algebra—Fundamental Operations, Fractions, Equations of the First Degree with one or several unknown quantities; Inequalities, Ratio and Proportion, Involution, including the Binomial Formula for an entire and positive Exponent; Evolution, the Reduction of Radicals, Equations of the Second Degree, Progressions, Permutations and Combinations, the Method of Indeterminate Coefficients, Fundamental Properties of Logarithms, Compound Interest.

Geometry—Plane, Solid, and Spherical; including fundamental notions of Symmetry, and examples of Loci and Maxima and Minima of Plane Figures.

Trigonometry—including the Analytical Theory of the Trigonometrical Functions, and the usual formulæ; the Construction and Use of Trigonometrical Tables; and the Solution of Plane Triangles; so much, for example, as is contained in Newcomb's Trigonometry to Art. 79, or in Wheeler's or Richards's or Wentworth's Plane Trigonometry. The Logarithmic and Trigonometric Tables furnished at the Examination will be Newcomb's (Henry Holt & Co., New York, 1882).

While no entrance examination is held in the *History of England*, candidates for admission are urgently advised to make themselves as familiar as possible with that subject; as a knowledge of it is essential to the most successful prosecution of some of the studies of the course.

Candidates will be allowed the option of passing on the above-named subjects in two successive years. In such cases they must present themselves for examination at the June examination of the first year in the following subjects or parts of subjects: *History of the United States, Geography, Arithmetic, Plane Geometry, and Algebra to Quadratic Equations.*

In order to have this preliminary examination counted, candidates must pass satisfactorily on four of the subjects; and notice of the intention to divide the examination must be given to Professor G. J. Brush, Director of the School, on or before June 15.

For preparation in Algebra, Geometry, and Trigonometry, the recently published text-books of Professor Newcomb (Henry Holt & Co., New York) may, without indicating undue preference, be especially recommended. And to the candidate who prepares in other works, they may serve to indicate the extent and kind of attainments expected in the prescribed topics. Candidates who prepare in the Geometry of this author, may for the present omit the short chapters on Ellipse, Hyperbola, and Parabola; though they will find it advantageous to study them.

In his preparation in GEOMETRY the candidate should, as far as practicable, have suitable exercises in proving simple theorems and solving simple problems for himself. It is important, too, that he should be accustomed to the numerical application of geometric principles, and especially to the prompt recollection and use of the elementary formulæ of mensuration. In TRIGONOMETRY he should be exercised in applying the usual formulæ to a variety of simple reductions and transformations, including the solution of trigonometrical equations. Readiness and accuracy in trigonometrical calculations are also of prime importance to the candidate. If the use of logarithms is postponed in his preparation till Trigo-

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nometry is taken up (which is by no means necessary or advisable), he should then have abundant applications of them to all forms of calculation occurring in ordinary practice, as well as to those appearing in the solution of triangles. Finally, in all of his calculations, he should study the art of neat and orderly arrangement.

In LATIN the student should have such continued training in parsing as shall make him thoroughly familiar with declensions and conjugations, and with the leading principles of Syntax. To secure these results more effectually, the requirement has been adopted of simple exercises in translating English into Latin. As this course of exercises is designed solely as a preparation for reading, it should be begun at the earliest stage of Latin study. A very large proportion of the deficiencies in the Latin examination for several years past has been due to the neglect of the suggestions of this paragraph, and to the attempt to read a Latin author with totally inadequate grammatical preparation.

The examinations for admission in 1884 take place at North Sheffield Hall, on Thursday, Friday, and Saturday, June 26, 27, 28 (beginning at 9 A. M. on Thursday); and on Tuesday and Wednesday, September 16, 17 (beginning at 9 A. M. on Tuesday). Opportunities for private examinations may, in exceptional cases, be given at other times.

In 1884 examinations (for the Freshman Class only) will also be held in Andover, Mass., in Chicago, in Cincinnati, in St. Louis, and in San Francisco (beginning on Thursday, June 26, at 9 A. M.), at places to be announced in local newspapers of the day previous. Candidates who propose to be present are requested to send their names to Professor G. J. Brush, Director of the School, before June 15. A fee of five dollars will be charged for admission to the examinations outside of New Haven.

Candidates for advanced standing in the undergraduate classes are examined, in addition to the preparatory studies, in those already pursued by the class they wish to enter. No one can be admitted as a candidate for a degree, later than at the beginning of the Senior year.

COURSES OF INSTRUCTION, occupying three years, are arranged to suit the requirements of various classes of students. The first year's work is the same for all; for the last two years the instruction is chiefly arranged in special courses.

The special courses most distinctly marked out are the following:

(*a.*) In Chemistry; (*b.*) In Civil Engineering;
(*c.*) In Dynamical (or Mechanical) Engineering;
(*d.*) In Agriculture; (*e.*) In Natural History;
(*f.*) In Biology preparatory to Medical Study;
(*g.*) In studies preparatory to Mining and Metallurgy;
(*h.*) In select studies preparatory to other higher studies.

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The arrangement of the studies is indicated in the annexed scheme.

FRESHMAN YEAR—INTRODUCTORY TO ALL THE COURSES:

FIRST TERM—*German*—Whitney's Grammar and Reader. *English*—Lounsbury's History of the English Language; Exercises in composition. *Mathematics*—Spherical Trigonometry (Newcomb's); Plane Analytical Geometry. *Physics*—Recitations, with experimental lectures. *Chemistry*—Recitations and Laboratory practice. *Elementary Drawing*—Practical Lessons in the Art School.

SECOND TERM—*Language, Physics and Chemistry*—as stated above. *Mathematics*—Plane Analytical Geometry, continued. *Physical Geography*—Lectures. *Botany*—Gray's Lessons, with Lectures. *Drawing*—Isometric Drawing, with application to drawing from models and structures by measurement. Shading and tinting. Principles of orthographic projection. Reading of working drawings and isometric construction of objects from their orthographic projections. Sections.

For the Junior and Senior year the students select for themselves one of the following courses:

(a.) IN CHEMISTRY:

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. *Qualitative Analysis*—Fresenius's. *Laboratory Practice. Blowpipe Analysis. German. French.*

SECOND TERM—*Theoretical Chemistry*—continued. *Laboratory Practice*—Quantitative Analysis and experimental work in Organic Chemistry. *Mineralogy*—Blowpipe Analysis and determination of species. Lectures. *French. German.*

SENIOR YEAR:

FIRST TERM—*Organic Chemistry*—Lectures and Recitations. *Agricultural Chemistry*—Recitations (optional). *Laboratory Practice*—Volumetric and Mineral Analysis. *Geology*—Dana's. *Zoology*—Lectures. *French.*

SECOND TERM—*Organic Chemistry*—continued. *Laboratory Practice*—Analysis of Minerals and Technical Products. *Assaying* (optional). *Geology*—Dana's Manual. *Mineralogy* (optional). *French.*

(b.) IN CIVIL ENGINEERING:

JUNIOR YEAR:

FIRST TERM—*Mathematics*—Analytical Geometry of Three Dimensions; Elements of the Theory of Functions; Differential Calculus. *Surveying*—Field Operations. *Drawing*—Descriptive Geometry, begun. *German. French.*

SECOND TERM—*Mathematics*—Integral Calculus; Rational Mechanics. *Drawing*—Descriptive Geometry, concluded; Topographical. *Surveying*—Topographical. *German. French.*

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SENIOR YEAR:

FIRST TERM—*Field Engineering*—Laying out Curves. Location of line of Railroad, with calculations of Excavation and Embankment. Hencks's Field Book for Railroad Engineers. Searles's Field Engineering. *Civil Engineering*—Resistance of Materials. Bridges and Roofs, begun. Stone Cutting, with Graphical Problems. *Geology*—Dana's. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *French.*

SECOND TERM—*Civil Engineering*—Bridges and Roofs. Building Materials. Stability of Arches and Walls. Mahan's Civil Engineering. *Dynamics*—Principles of Mechanism. Steam Engine. *Hydraulics*—Hydraulics and Hydraulic Motors. *Drawing*—Graphical Statics. *Astronomy*—Loomis's Astronomy with practical problems. *Mineralogy*—continued. *Geology*—Dynamic. *French.*

(c.) IN DYNAMIC ENGINEERING:

JUNIOR YEAR:

FIRST TERM—*Mathematics*—Analytical Geometry of Three Dimensions; Elements of the Theory of Functions; Differential Calculus. *Surveying*—Field Practice. *Drawing*—Descriptive Geometry, begun. *German. French.*

SECOND TERM—*Mathematics*—Integral Calculus; Rational Mechanics. *Kinematics*—General Theory of Motion and Principles of Mechanism; Elementary Combinations of Pure Mechanism; Pulleys and Belts; Gearing and forms of teeth for Wheels; Parallel Motions. *Drawing*—Descriptive Geometry, concluded. *German. French.*

SENIOR YEAR:

FIRST TERM—*Statics*—Application of the Principles of Statics to Rigid Bodies: Elasticity and Strength of Materials; Forms of Uniform Strength; Stability of Structures; Construction of Roof Trusses. Girders, and Iron Bridges. *Machine Drawing*—Bolts and Nuts; Riveting; Journals, Axles, Shafts, Couplings, Pillow Blocks; Shaft-hangers, Pulleys; Connecting Rods and Cranks; Cross-heads; Pipe connections; Valves; Steam Cylinders, Stuffing Boxes, Glands, etc. Shop Visits. *Blowpipe Analysis. French.*

SECOND TERM—*Hydrostatics and Hydrodynamics*—Equilibrium and Pressure of fluids; Hydrometers, Manometers, Gauges, etc.; Water Pressure Engines and Water Wheels; Construction of Water Reservoirs and Conduits; Measurement of Water Supply; Discharge of Pipes. *Thermodynamics*—General principles of Heat employed as a source of power; Theory of the Steam Engine; Hot Air Engines; Gas Engines. *Machine Designing*—Proportioning of Machine Parts, continued. Designing of Hoisting Engines; Shearing and Pumping Engines; Complete working drawings for a high speed Steam Engine. Shop Visits and Reports. *Metallurgy.*

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(d.) IN AGRICULTURE:

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. *Qualitative Analysis*—Fresenius's. *Laboratory Practice. Blowpipe Analysis. German. French.*

SECOND TERM—*Theoretical Chemistry*—continued. *Laboratory Practice*—Quantitative Analysis. *Mineralogy*—Blowpipe Analysis and Determination of Species. *Physiology*—Huxley's. *Botany. French. German.*

SENIOR YEAR:

FIRST TERM—*Agriculture*—Cultivation of the Staple Crops of the Northern States. Tree Planting and Forestry. *Agricultural Chemistry*—Johnson's. *Organic Chemistry*—Lectures and Recitations. *Geology*—Dana's. *Botany. Zoology. English. French.*

SECOND TERM—*Agriculture*—Laws of Heredity and Principles of Breeding; Lectures. *Geology*—Dana's. *Rural Economy*—Systems of Husbandry. *Agricultural Chemistry*—Johnson's. *Organic Chemistry*—continued. *Geology*—Dana's. *Zoology. Botany. Microscopy. English. French.*

(e.) IN NATURAL HISTORY:

(Either Geology, Mineralogy, Zoology, or Botany, may be made the principal study, some attention in each case being directed to the other three branches of Natural History.)

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. *Qualitative Analysis*—Fresenius's; Laboratory Practice; Recitations. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *Botany*—Gray's Manual; Laboratory Practice. *German. French.*

SECOND TERM—*Zoology*—Laboratory Practice; Recitations; Excursions (land and marine). *Botany*—Laboratory Practice; Excursions. *Physiology*—Huxley's. *Mineralogy*—continued. *Physical Geography. German. French.*

SENIOR YEAR:

FIRST TERM—*Geology*—Dana's; Excursions. *Zoology*—Laboratory Practice; Lectures; Recitations; Excursions. *Botany*—Herbarium Studies; Gray's Textbook; Excursions. *French.*

SECOND TERM—*Geology*—Dana's. *Anatomy of Vertebrates*—Huxley's. *Zoology*—Laboratory Practice; Recitations; Lectures. *Botany*—Herbarium Studies, especially in the Cryptogamous Orders; Botanical Literature; Essays in Descriptive Botany. *Meteorology. French.*

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Besides the regular courses or recitations and lectures on structural and systematic Zoology and Botany, and on special subjects, students are taught to prepare, arrange, and identify collections, to make dissections, to pursue original investigations, and to describe genera and species in the language of science. For these purposes, large collections in Zoology and Palæontology belonging to the College are available, as are also the private botanical collections of Professor Eaton.

(f.) IN BIOLOGY PREPARATORY TO MEDICAL STUDIES:

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. *Qualitative Analysis*—Fresenius's; Laboratory Practice; Recitations. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *German. French.*

SECOND TERM—*Anatomy and Histology*—Laboratory Practice, Lectures and Recitations. *Physiology*—Huxley's; Practical Exercises. *Embryology*—Lectures. *Theoretical Chemistry*—continued. *Mineralogy*—continued. *Botany*—Lectures; Practical Exercises in Phenogamous Plants; Excursions. *German. French.*

SENIOR YEAR:

FIRST TERM—*Physiological Chemistry*—Recitations, Laboratory Practice and Lectures. *Organic Chemistry*—Lectures and Recitations. *Zoology*—Lectures. *Botany*—Practical Exercises. Lectures and Excursions. *Geology*—Dana's Manual. *French.*

SECOND TERM—*Physiological Chemistry*—continued. *Experimental Toxicology. Geology*—Dana's Manual. *Zoology*—Lectures. *Sanitary Science*—Lectures. *Laws of Heredity and Breeding*—Lectures. *French.*

(g.) IN STUDIES PREPARATORY TO MINING AND METALLURGY:

Young men desiring to become Mining Engineers can pursue the regular course in Civil or Mechanical Engineering, and at its close can spend a fourth year in the study of metallurgical chemistry, mineralogy, etc.

(h.) IN THE SELECT STUDIES PREPARATORY TO OTHER HIGHER STUDIES:

JUNIOR YEAR:

FIRST TERM—*Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *Physical Geography*—Guyot; Lectures. *English*—Early English. *History*—Bright's History of England. *French. German.*

SECOND TERM—*Mineralogy*—Lectures. *Astronomy. Botany*—Lectures; Excursions; Laboratory Practice. *English*—Chaucer, Bacon, Shakspere. *History*—Bright's History, continued; History of the United States. *German. French.*

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SENIOR YEAR:

FIRST TERM—*Geology*—Recitations and Excursions. *Zoology*—Lectures and Excursions. *Linguistics*—Whitney's Life and Growth of Language. *English*—Shakspere. *Constitutional Law of the United States. French.*

SECOND TERM—*Geology*—continued. *Meteorology*—Lectures. *Sanitary Science*—Lectures. *Political Economy*—Recitations and Lectures. *English*—Shakspere, Milton, Dryden, Pope, Gray, and later authors. *French.*

Exercises in English Composition are required during the entire course from all the students. The preparation of graduating theses is among the duties of Senior Year.

Lectures on Military Science and Tactics are annually given by General Abbott, and other officers of the Engineer Corps of the United States Army.

DRAWING.—The course in drawing extends through the three years. During the first term of Freshman year, the students practice free-hand drawing at the Art School building, under the direction of Professor Niemeyer, of the Yale School of the Fine Arts. After the completion of the course in free-hand drawing, instruction is given by Mr. F. R. Honey, during the second term in the elementary principles of instrumental drawing, embracing Elementary projection drawing, Isometric drawing, and Descriptive Geometry as far as warped Surfaces. This course is obligatory upon all.

During the Junior and Senior years, instruction in drawing is obligatory only on the students in Civil and Mathematical Engineering. In the former year the system of instruction embraces shades and shadows, tinting, perspective, and warped surfaces. By this method all the problems in Descriptive Geometry are required to be worked out on the drawing-board instead of the black-board. The course extends through the entire year, and is under the direction of Mr. Honey.

In Senior year, students are required to apply the principles of drawing already obtained to works of construction, under the general supervision of the Professors of Civil and of Dynamic Engineering.

VII.

METHODS OF INSTRUCTION.

The instruction of this institution is given chiefly in small class-rooms, in connection with recitations and by familiar lectures, illustrated by the apparatus at the command of the various

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teachers. In many studies weekly excursions are made for the purpose of collecting specimens and examining natural phenomena.

In Chemistry and Metallurgy the students work several hours daily in well-appointed laboratories, under the direct superintendence of the instructors, and are guided through systematic courses of quantitative and qualitative analysis, assaying, and the blow-pipe determination of minerals and ores.

In the course in Biology, instruction in Comparative Anatomy and Histology is given in the laboratory five or six mornings each week; the student working out for himself, by dissection and the examination of preparations, the anatomy of several types of animals, and making a large part of the microscopical preparations used in the study of the different tissues. In Physiological Chemistry the student works four hours daily in the study of the chemical processes of the body and in the preparation and examination of the more important proximate principles; thus, under the head of nutrition the various digestive processes are suggestively studied, artificial digestions are made, the products are separated and examined, while their physiological functions are demonstrated by experiments on animals. Special attention is also paid to the micro-chemistry of the various tissues. Students are likewise trained in qualitative and quantitative analysis of urine, both in health and disease, not alone for the practical results to be obtained, but especially for the means which it affords of studying the metabolic changes of the body. Toxicology is taught by experiments on animals; the absorption and elimination of poisons, together with other points of physiological value, being demonstrated by chemical analysis of tissues and secretions. In each of these subjects laboratory instruction is supplemented by recitations and lectures.

In Botany, during the summer of Junior year, exercises in analyzing and identifying plants occur two or three times a week, followed by practice in writing characters and descriptions of plants from living specimens. Students are shown also the best methods of collecting and preserving for future study, specimens of Flowering Plants, Ferns, Mosses, Algæ, etc. In the autumn term of Senior year the work of the summer is continued. Students are encouraged to pursue special lines of Botanical investigation, and varied assistance is rendered them according to their needs. The final examination is intended to show what they have learned, and the collections they have made are considered to be of minor importance.

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In Zoology excursions are made during the Summer term of Junior and Fall term of Senior year, in company with the instructors, for the purpose of observing the habits and making collections of marine, fresh-water, and terrestrial animals of all classes. Each student is required to prepare and present for examination a collection containing a specified number of species, and illustrating the various classes of animals. He must also be able to pass an examination upon his collection, at least to the extent of explaining the classes and orders illustrated, and showing why particular specimens belong to the respective classes.

In Geology excursions are made for the purpose of examining geologial phenomena and making special collections of rocks and minerals. Each student is required to pass a satisfactory examination on his collection at the end of the first term of Senior year.

In Civil Engineering the students, besides attending on Class recitations and lectures, pursue a systematic course of exercises in the different branches of Geometrical Drawing and Graphical Statics, and in the application of the principles of drawing to works of construction; and have good practice in the operations of Surveying and Field Engineering—acquiring facility in the use and adjustment of Surveying and Engineering Instruments. In Topographical Surveying they are instructed in the use of the Plane Table for topographical work, and are required to prepare a detailed chart of the ground surveyed—exhibiting the contour lines and all its topographical features. Numerous problems of computation, and graphical exercises, are included in the Course of Construction pursued in the Senior year. A course of Blow-pipe Analysis is also taken by the Senior Class, that a more thorough knowledge may be gained of minerals and building stones.

In Dynamic Engineering the method of instruction is by recitation and lectures, supplemented by work in the drawing room, by shop visits, and visits of inspection in and out of the city, and by tests with the indicator and dynamometer. The lectures are illustrated by models, by large cartoons adapted for the purpose, and by the complete collection of working drawings of the Novelty Iron Works, owned by the School. In the drawing room, detailed working drawings of various machines are made. A general sketch of the proposed machine is given and complete detailed drawings are required, in proper shape for the pattern-maker or machinist. The student is taught the best practice,

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and his judgment is trained in choosing relative proportions. The student is required to describe the steps to be followed in building the machine, and to make as nearly as possible an estimate of its cost. Pattern, foundry, blacksmithing and machine work are studied in detail. In the visits, machinery and processes are critically examined in detail, and sketches of important machines with written descriptions are required.

In addition to the above, a course of lectures is given every winter by the professors of the schools and others, on topics of popular interest.

VIII.

TUITION CHARGES.

The charge for tuition for undergraduate students is $150 per year, payable, $55 at the beginning of the first and of the second term, and $40 at the middle of the second term. The student in the Chemical course has an additional charge of $70 per annum for chemicals and use of apparatus. He also supplies himself at his own expense with gas, flasks, crucibles, etc., the cost of which should not exceed $10 per term. A fee of $5 is charged members of the Freshman Class for chemicals and materials used in their laboratory practice, and the same fee is required from all (except Chemical students) who take the practical exercises in Blow-pipe Analysis and Determinative Mineralogy. A fee of $5 a term will also be charged to the students in the Zoölogical laboratory, for materials and use of instruments. An additional charge of $5 is annually made to each student for the use of the College Reading Room and Gymnasium.

For graduate students the charge for tuition of $100 per year.

IX.

CHURCH SITTINGS.

Free sittings for students in this department of Yale College are provided as follows: in the Center Church (Congr.); in the Trinity (Episc.); and in the First Methodist Church.

Those who prefer to pay for a sitting for a year, more or less, in the churches above mentioned, or in any other church of any denomination, will be aided on application to the Secretary of the School.

Sittings in the Gallery of the College Chapel are free as heretofore to the students of this department.

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X.

DEGREES.

Students of this department, on the recommendation of the Governing Board, are admitted by the Corporation of Yale College to the following degrees. They are thus conferred:

1. BACHELOR OF PHILOSOPHY: on those who complete any of the three-years courses of study, passing all the examinations in a satisfactory manner, and presenting a graduation thesis.

The fee for graduation as Bachelor of Philosophy, including the fee for Triennial Catalogues, Commencement Dinners, etc., is $10; unless the person taking the degree is also an academical graduate, when it is but $5.

2. CIVIL ENGINEER and DYNAMICAL ENGINEER: The requirements for these degrees are stated on page 19.

3. DOCTOR OF PHILOSOPHY: The requirements for this degree are stated on page 17.

XI.

TERMS AND VACATIONS.

The next academic year begins Thursday, September 18, 1884. The first term begins twelve weeks from Commencement-day and continues thirteen weeks: the second term begins regularly on the first Thursday in January and continues until Commencement-day, with a spring recess—usually of eight days—including Easter. (See Calendar, p. 2.)

XII.

ANNOUNCEMENT IN RESPECT TO STATE STUDENTS.

The scholarships established in this School in consequence of the bestowal upon it of the Congressional grants are designed to aid young men who are in need of pecuniary assistance in fitting themselves for agricultural and mechanical pursuits of life. All applicants must be citizens of Connecticut. In case there are more applicants than vacancies, candidates will be preferred who have lost a parent in the military or naval service of the United States, and next to these such as are most in need of pecuniary assistance; and the appointments will be distributed as far as

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practicable among the several counties in proportion to their population. The appointing Board for the current year, consisting of the Board of Visitors of the State and the Secretary of the School, will meet on June 24, 1884, and at or about the same time in the year 1885, due notice of which will be given by publication in every county in the State. All applications should be made previous to that time. Blank forms for application will be sent, when requested, by Professor GEORGE J. BRUSH, Secretary of the Appointing Board.

XIII.

ANNIVERSARY.

The Anniversary of the School is held on Tuesday of the Commencement week in Yale College, when selections from the graduation theses are publicly read. The degrees are publicly conferred by the President and Fellows of Yale College on Commencement Day.

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APPENDIX

ENTRANCE EXAMINATION PAPERS.

The following are the papers for 1883, upon which applicants for admission were examined at the June and September examinations.

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ARITHMETIC.

JUNE, 1883.

1. Find the greatest common divisor of 36864 and 20736.

2. Multiply $\frac{3}{4}$ of $\frac{8\frac{1}{3}}{6\frac{2}{3}}$ by $\frac{4}{5}$ of $\frac{\frac{3}{7}}{16}$.

3. (*a*) Give the table of Metric weights.

(*b*) A cubical cistern holds 1331 kilograms of water: what is the length of an inner edge?

4. Divide 67.56785 by .035 and multiply the result by $\frac{7}{8}$. Explain the position of the decimal point after division.

5. How much money should be received on a note of $1000, payable in 4 months, discounting at a bank where the interest is 6 per cent.?

6. If a man travel 117 miles in 15 days, employing only 9 hours a day, how far would he go in 20 days, traveling 12 hours a day?

7. Extract the square root of 10 to five places.

ARITHMETIC.

SEPTEMBER, 1883.

1. (*a*) Select the prime numbers between 50 and 100.

(*b*) What is the least number that can be exactly divided by $\frac{1}{15}$, $2\frac{1}{2}$, 5, $6\frac{1}{3}$ and $\frac{1}{11}$.

2. Reduce 0.00096 to its simplest equivalent common fraction.

3. 7465 is $33\frac{1}{3}$ per cent. of what number?

4. A broker bought 84 shares of railroad stock at 19 per cent. discount. He sold 35 shares at $27\frac{1}{2}$ per cent. discount, and the balance at 8 per cent. discount. Did he gain or lose, and how much?

5. Calculate the cube root of 3.7 to five decimal places.

6. Give the approximate value of the meter in feet; of the kilogram in pounds avoirdupois.

7. Find the weight in kilos of 15 gallons of water.

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GEOMETRY.

JUNE, 1883.

NOTE 1.—Candidates for examination on the whole of this subject should take the whole of this paper. Candidates for the first year's partial examination should take the first part; those for the second year's partial examination, the second part.

NOTE 2.—State what text-book you have studied on the subject, and to what extent.

I.—PLANE GEOMETRY.

1. (*a*) Define the symmetry of a figure with respect to a point and with respect to an axis.

(*b*) Determine the symmetrical figure of a triangle with respect to a point lying within and with respect to an axis cutting the triangle.

2. The three perpendiculars from the vertices of a triangle to the opposite sides meet in the same point.

3. To construct a polygon similar to a given polygon, the ratio of similitude of the two polygons being given.

4. (*a*) What is the area of a circle circumscribed about a square whose side is a?

(*b*) What must be the diameter of a circle in order that the length of its circumference may be 100 feet?

5. To find the locus of the point from which a given line subtends a right angle.

6. Of all triangles having the same base and equal areas, that which is isosceles has the minimum perimeter.

II.—SOLID AND SPHERICAL GEOMETRY.

7. Between two lines not in the same plane one, and only one, common perpendicular can be drawn.

8. All parallelopipeds having the same base and equal altitudes are equal in volume.

9. Show that opposite spherical triangles are symmetrical. If two symmetrical spherical triangles are isosceles, they are identically equal.

10. Write expressions for the lateral area and volume of the prism and regular pyramid: also for the entire surface and volume of the right cylinder and sphere.

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GEOMETRY.

SEPTEMBER, 1883.

[State what text-book you have studied, and to what extent.]

1. Every point in the bisector of an angle is equally distant from the sides of the angle; and every point within the angle, but not on the bisector, is nearer that side toward which it lies.

2. If the sum of two opposite angles of a quadrilateral is equal to two right angles, the vertices of the four angles lie on a circle.

3. (*a*) Write expressions for the area of the triangle, parallelogram, trapezoid and circle.

(*b*) The areas of similar figures are to each other in what ratio?

(*c*) How would you find the area of any quadrilateral?

4. (*a*) When is a variable magnitude said to have a *limit?* Give an example to illustrate the definition.

(*b*) Apply the theory of limits to show that the area of a circle is equal to half the product of its circumference by its radius.

5. If from any point perpendiculars be dropped upon two intersecting planes, the angle between these perpendiculars will be equal to the dihedral angle between the planes, adjacent to the angle in which the point is situated.

6. The area of a spherical triangle is proportional to its spherical excess.

7. Required the entire surface and volume of a right cone whose altitude is 12 feet, and the diameter of its base 15 feet.

8. The radius of a sphere is bisected at right angles by a plane. What is the ratio of the two parts into which the plane divides the spherical surface?

ENGLISH GRAMMAR.

JUNE, 1883.

1. Define the *subject* and the *predicate* of a sentence.

2. Give the two methods of comparing the adjective.

3. State the distinction existing between the old (or strong) and the new (or weak) conjugation of the verb, and give three examples of verbs of each conjugation.

4. Parse the words in the following sentence:

He, by whom the sword of the law is borne, is himself the law's servant, and not its master.

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ALGEBRA.

JUNE, 1883.

NOTE 1.—Candidates for examination in this subject as a whole should take the whole of this paper; those for the first year's partial examination, the first part of it; those for the second year's partial examination, the second part.

NOTE 2.—State at the head of your paper what text-book you have studied on the subject, and to what extent.

I.

1. Reduce to their simplest forms the fractions

(1) $\frac{ac+bd+ad+bc}{af+2bx+2ax+bf}$; (2) $\frac{ax^m-bx^{m+1}}{a^2bx-b^2x^2}$.

2. Given $\frac{ace}{d}-\frac{(a+b)^2x}{a}-bx=ae-3bx$ to find x.

3. A sum of money, at simple interest, amounted in m years to a dollars, and in n years to b dollars. Find the sum and the rate of interest.

4. Prove that if $\frac{x-y}{m}<1-\frac{x}{y}$, and m is positive then $x<y$.

5. (1) Simplify $(a^3b^3)^{\frac{1}{3}}+(a^2c^6)^{\frac{1}{3}}$.

(2) Extract the square root of $6hm^{2n}+h^2+9m^{4n}$.

(3) Reduce $\frac{\sqrt{x+a}+\sqrt{x-x}}{\sqrt{x+a}-\sqrt{a-a}}$ to an equivalent fraction with a rational denominator.

II.

6. Given $15x^2-20x=35$ to find x.

7. Given $\frac{x+\sqrt{x^2-9}}{x-\sqrt{x^2-9}}=(x-2)^2$ to find x.

8. Given $x^2-xy=48$, and $xy-y^2=12$ to find x and y.

9. The number of permutations of n things taken r together is equal to 10 times the number when taken $r-1$ together; and the number of combinations of n things taken r together is to the number when taken $r-1$ together as 5 to 3: required the value of n and r.

10. Expand $\frac{3+2x}{5+7x}$ into a series of ascending powers of x, by the method of indeterminate co-efficients. (Four terms of the series will be sufficient.)

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ALGEBRA.

SEPTEMBER, 1883.

[State what text-book you have studied on the subject, and to what extent.]

1. Given $\frac{x-y+1}{x-y-1}=a$, and $\frac{x+y+1}{x+y-1}=b$, to find x and y.

2. Simplify (1) $\sqrt{27}+2\sqrt{48}+3\sqrt{108}$. (2) $(\sqrt[7]{a^2b})^3(\sqrt[7]{a^3b^{13}})^4$.

(3) $\frac{x^{2p(q-1)}-y^{2q(p-1)}}{x^{p(q-1)}+y^{q(p-1)}}$.

3. From an equation whose roots shall be 2 and -3. Resolve x^2-3x+4 into two factors.

4. Given $\frac{1}{x}+\frac{1}{y}=5$ and $\frac{1}{x^2}+\frac{1}{y^2}=13$ to find x and y.

5. Given $\frac{3x+\sqrt{4x-x^2}}{3x-\sqrt{4x-x^2}}=2$ to find x.

6. To deduce a formula for the sum of a geometric progression in terms of the first term, the ratio, and the number of terms.

7. Having 10 different letters, how many sets of two each can you form of them, differing by at least one letter.

8. Expand $\frac{1}{1-2x+x^2}$ into a series of ascending powers of x by the method of indeterminate coefficients. (Four terms of the series will suffice.)

9. Express log $\sqrt[3]{\frac{ab^2c^4}{d^5}}$ in a form adapted to computation.

10. To deduce a formula for the amount of a given sum of money for a given time at a given rate of compound interest.

TRIGONOMETRY.

JUNE, 1883.

[State what text-book you have studied on the subject, and to what extent.]

1. Explain the circular measure of an angle. Express an angle of 1.5 in degrees.

2. Give the algebraic signs of the Trigonometric functions for angles terminating in each of the four quadrants, and the values of the functions of 0, $\frac{\pi}{2}$, π, $\frac{3\pi}{2}$.

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3. State some of the fundamental relations existing between the different functions of the same angle.

4. Find an angle whose tangent is double its sine.

5. Write the different formulas which serve to solve right-angled triangles, and explain their application.

6. Find a formula for expressing $\sin \frac{1}{2}\alpha$ in terms of $\cos \alpha$.

7. If a, b, and c are the sides of a triangle and α the angle opposite the side a, show that

$$a^2 = b^2 + c^2 - 2bc \cos \alpha.$$

Also state any application you have made of this formula.

8. In a triangle given $A = 32°$, $a = 40$, $b = 50$, to find one solution of the triangle. Is there more than one? If so, how do you recognize the fact?

TRIGONOMETRY.

SEPTEMBER, 1883.

[State what text-book you have studied on the subject, and to what extent.]

1. Express an angle of 75° in radius.

2. Express each of the functions of $\left(\frac{\pi}{2} + \alpha\right)$ by a function of α.

3. Form a general expression for all angles which have the same cosine.

4. What must the value of the cosine be in order that the tangent may be n times the sine?

5. To find a formula for the tangent of the sum of two angles in terms of the tangents of the angles; and from this formula to derive an expression for the tangent of twice an angle in terms of the tangent of the angle.

6. In a triangle ABC, given the angle $A = 118° 04'$, and the adjacent sides, $b = 960$, and $c = 1686$, to find the remaining angles and side of the triangle.

LATIN.

JUNE, 1883.

I. Translate as literally as possible:

a. Ubi de ejus adventu Helvetii certiores facti sunt, legatos ad eum mittunt, nobilissimos *civitatis*, cujus legationis Nameius et Verudoctius principem locum obtinebant, qui dicerent, *sibi* esse in animo sine ullo maleficio iter per provinciam facere, propterea quod aliud iter haberent nullum.

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b. Temporis tanta fuit exiguitas hostiumque tam paratus ad dimicandum animus, ut non modo ad *insignia* accommodanda, sed etiam ad galeas induendas scutisque tegimenta detrudenda tempus defuerit. Quam quisque ab opere in partem *casu* devenit, quaeque prima signa conspexit, ad haec constitit, ne in quaerendis suis pugnandi tempus dimitteret.

c. Hac re perspecta, Crassus, quum sua cunctatione atque opinione timoris hostes nostros milites alacriores ad pugnandum effecissent, atque omnium voces audirentur, *exspectari* diutius non *oportere*, quin ad castra iretur, cohortatus suos, omnibus cupientibus, ad hostium castra contendit.

d. Genus hoc est ex essedis pugnae: primo per omnes partes perequitant et tela conjiciunt, atque ipso *terrore* equorum et strepitu rotarum ordines plerumque perturbant, et quum se inter equitum turmas insinuaverunt, ex essedis desiliunt et *pedibus* proeliantur.

e. Qua re animadversa, Ambiorix pronuntiari jubet, ut procul tela conjiciant, neu propius accedant, et quam in partem Romani impetum fecerint, cedant (levitate armorum et quotidiana exercitatione *nihil iis* noceri posse), rursus se ad signa recipientes insequantur.

f. Erat aeger in praesidio relictus Publius Sextius Baculus, qui primum pilum ad Caesarem duxerat, cujus mentionem superioribus proeliis fecimus, ac diem jam quintum *cibo* carerat. Hic diffisus suae atque omnium saluti *inermis* ex tabernaculo prodit: videt imminere hostes atque in summo esse rem discrimine: capit arma a proximis atque in porta consistit.

II.—1. Decline *adventu* (1), *principem* (3), *ullo* (4).

2. Compare *certiores* (1); *nobilissimos* (2), *prima* (10).

3. Write the synopsis, active and passive, of *mittunt* (2).

4. Parse in full each word in the last two lines of passage *b*.

5. Give the principal parts of the following: *obtinebant* (3), *detrudenda* (8), *effecissent* (14), *oportere* (15), *iretur* (15), *contendit* (16), *conjiciunt* (18), *desiliunt* (20), *cedant* (24), *noceri* (25), *relictus* (27), *diffisus* (30).

6. State the construction of all italicized words.

7. Quote (in full) from the above text an example of indirect statement.

8. Change into direct statement the example quoted in answer to question seventh.

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LATIN.

September, 1883.

I. Translate as literally as possible:

a. Is ita cum Caesare agit: Si pacem populus Romanus cum Helvetiis faceret, in eam partem ituros atque ibi futuros Helvetios, ubi eos Caesar constituisset atque esse voluisset; sin *bello* persequi perseveraret, reminisceretur et veteris *incommodi* populi Romani et pristinae virtutis Helvetiorum.

b. Caesar quum septimam legionem, quae juxta constiterat, item urgeri ab hoste vidisset, tribunos militum monuit, ut paulatim sese legiones conjungerent et conversa signa in hostes inferrent. Quo facto, quum *alius alii* subsidium ferrent, neque timerent ne aversi ab hoste circumvenirentur, audacius resistere ac fortius pugnare coeperunt.

c. Una erat magno *usui* res praeparata a nostris, falces praeacutae, insertae affixaeque *longuriis*, non absimili *forma* muralium *falcium*. His quum funes, qui antennas ad malos destinabant, comprehensi adductique erant, navigio remis incitato praerumpebantur.

d. Caesar questus, quod, quum ultro in continentem legatis missis pacem ab se petissent, bellum sine causa intulissent, ignoscere *imprudentiae* dixit obsidesque imperavit; quorum illi partem statim dederunt, partem ex longinquioribus locis arcessitam paucis diebus sese daturos dixerunt.

e. His circumventis, magna manu Eburones, Nervii, Aduatuci atque horum omnium socii et clientes legionem oppugnare incipiunt: nostre celeriter ad arma concurrunt, vallum conscendunt. Aegre is dies sustentatur, quod omnem spem hostes in celeritate ponebant atque hanc adepti victoriam in perpetuum se fore *victores* confidebant.

f. Multum quum in omnibus rebus, tum in re militari potest fortuna. Nam sicut magno accidit casu, ut in ipsum incautum etiam atque imparatum incideret, priusque ejus adventus ab hominibus videretur, quam fama aut nuntius afferretur; ic magnae fuit *fortunae* omni militari *instrumento*, quod circum se habebat, erepto, rhedis equisque comprehensis, ipsum effugere mortem.

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II.—1. Decline *bello* (4), *veteris* (4), *alius* (9).

2. Compare *veteris* (4), *audacius* (10), *fortius* (11).

3. Write the synopsis, active and passive, of *agit* (11).

4. Parse in full each word in the last two lines of passage *d*.

5. Give the principal parts of the following: *voluisset* (3), *persequi* (4), *reminisceretur* (4), *inferrent* (9), *aversi* (10), *insertae* (13), *comprehensi* (16), *praerumpebantur* (16), *questus* (17), *petissent* (18), *adepti* (26), *erepto* (33).

6. State the construction of all italicized words.

7. Quote (in full) from the above text an illustration of indirect statement.

8. Convert into direct statement the example quoted in answer to question seventh.

LATIN EXERCISES.

JUNE, 1883.

1. The envoys[1] come[2] to[3] Caesar.[4]

2. The envoys will come to Caesar.

3. Caesar sends back[5] the envoys immediately.[6]

4. The envoys were immediately sent back by Caesar.

5. The envoys, who[7] came to Caesar, were immediately sent back.

6. If[8] the envoys had come to Caesar, they would have been immediately sent back.

7. Caesar forms[9] the design[10] of sending back the envoys. (Use gerundive construction.)

8. (Rewrite sentence seventh and use gerund instead of gerundive.)

9. It is said, "Caesar has sent back the envoys."

10. (Rewrite sentence ninth so as to employ indirect statement.)

[1] legatus. [2] venīre. [3] ad [4] Caesar. [5] remittĕre. [6] statim. [7] qui. [8] si. [9] capĕre. [10] consilium.

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LATIN EXERCISES.

SEPTEMBER, 1883.

1. The Helvetians[1] burn[2] four hundred[3] villages.[4]
2. Four hundred villages are burned by the Helvetians.
3. The Helvetians will burn four hundred villages.
4. Four hundred villages will be burned by the Helvetians.
5. Caesar[5] says[6] (that) the Helvetians have burned four hundred villages.
6. (Rewrite sentence sixth and substitute direct statement.)
7. The Helvetians formed[7] the plan[8] of burning four hundred villages. (Use the gerundive construction.)
8. (Rewrite sentence seventh and use gerund instead of gerundive.)
9. The Helvetians say they will burn four hundred villages.
10. (Rewrite sentence ninth so as to illustrate direct statement.)

[1] Helvetius. [2] incendĕre. [3] quadringenti. [4] vicus. [5] Caesar. [6] dicĕre. [7] capĕre. [8] consilium.

HISTORY OF THE UNITED STATES.

JUNE, 1883.

1. Give in chronological order the following dates: La Salle's exploration of the Mississippi; Battle of the Brandywine; Presidencies of John Quincy Adams, Van Buren, Taylor; King Philip's War; Frobisher's first voyage; Settlement of Jamestown.
2. Describe the settlement of New York, and explain the origin of its name.
3. Show the differences between royal, proprietary and charter colonies.
4. Give with their dates the principal events that led to the revolt of the colonies from the passage of the stamp act to the battle of Lexington.
5. What were the Virginia and Kentucky resolutions, and by what were they occasioned?
6. State the causes and the general results of the Mexican war.

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HISTORY OF THE UNITED STATES.

SEPTEMBER, 1883.

1. Give in chronological order the following dates: Battle of Lundy's Lane; Settlement of Maryland; Invasion of Mexico; Trials for witchcraft at Salem; Presidencies of Polk, Buchanan, Jackson; Emancipation of the slaves.

2. Give an account of the foundation of the Connecticut and New Haven colonies.

3. When, for what purpose, and on what terms was the New England confederation formed?

4. Give the date, causes and results of the French and Indian war.

5. When was the treaty of Ghent made, and what were its provisions?

6. Give an account of the compromise of 1850, and the questions which it was intended to settle.

GEOGRAPHY.

JUNE, 1883.

1. Bound the State of Colorado; give the names of two rivers in it, and tell where they rise, run and empty; give the name of one city in it and tell where it is situated.

2. If we travel due south from lake Michigan to the gulf of Mexico, what States should we touch?

3. Bound France; give the names of two rivers in it, and tell where they rise, run and empty; give the names of two cities in it and tell where they are situated.

4. Where are the following cities: Santiago, Salem, Singapore, Sacramento, Sydney, Savannah?

5. What States and Provinces touch lake Erie? Give the names of three rivers that empty into it and tell where they come from.

6. Give the names of four seaports in Asia, tell what countries they are in and how they are situated.

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GEOGRAPHY.

SEPTEMBER, 1883.

1. Bound the State of Michigan; give the names of two cities in it and tell where they are situated.

2. If we travel due west from North Carolina to the Pacific Coast what States and Territories should we touch?

3. Bound Russia; what is its capital and where is it situated; give the name of one other city in Russia and tell where it is situated.

4. Where are the following cities: Manchester, Manila, Marseilles, Madrid, Memphis, Minneapolis?

5. What countries of Africa touch the Atlantic ocean? Give their names in their order from north to south.

6. Give the names of four seaports in South America, tell what countries they are in and how they are situated.

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The Annual Report will be sent regularly to all graduates who may express the desire to receive it, and who furnish their addresses for the purpose. It is desirable that any change of address should be communicated by the first of January of each year.

For Circulars and other information, address

PROFESSOR G. J. BRUSH,

NEW HAVEN, CONN.

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NINETEENTH ANNUAL REPORT

OF THE

SHEFFIELD SCIENTIFIC SCHOOL

OF

YALE COLLEGE,

1884-85.

PRINTED BY ORDER OF THE GENERAL ASSEMBLY.

NEW HAVEN:
TUTTLE, MOREHOUSE & TAYLOR, PRINTERS.
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STATE BOARD OF VISITORS.

CONSTITUTING, WITH THE SECRETARY OF THE SCHOOL, THE BOARD FOR THE APPOINTMENT OF STATE STUDENTS.

Governor.

His Excellency THOMAS M. WALLER, New London.

Lieutenant-Governor.

His Honor GEORGE G. SUMNER, Hartford.

State Senators.

Hon. LORIN A. COOKE, Barkhamsted.
Hon. JOSEPH W. ALSOP, Middletown.
Hon. EBENEZER C. DENNIS, Stafford.

Secretary of State Board of Education.

CHARLES D. HINE.

Secretary and Treasurer of the School.

GEORGE J. BRUSH.

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REPORT

OF THE

STATE BOARD OF VISITORS.

To the General Assembly of the State of Connecticut:

The Governor, Lieutenant-Governor, three senior Senators and the Secretary of the Board of Education, comprise the State Board of Visitors of this institution.

These officials, with the Secretary of the school and the Secretary of the State Board of Education, have the selection of students to fill the State scholarships. This discretion is exercised in accordance with rules that experience has proven to be fair and impartial, and to best subserve the policy of the State in relation thereto.

The Governing Board of the School is appointed by the Yale College Corporation. Their nineteenth annual report, we have the honor of herewith presenting, is in every way gratifying. Its exhibit of the work this institution is doing, and the prosperity it is enjoying, is evidence of the ability and devotion of its managers, professors and teachers, and the growing appreciation in the country of the scientific, industrial and technical education, this school affords.

THOMAS M. WALLER,
Chairman.

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ANNUAL STATEMENT

OF THE

GOVERNING BOARD.

THE SHEFFIELD SCIENTIFIC SCHOOL has on its rolls for the current academic year the largest number of names it has ever been able to report. Ten years ago the attendance was nearly as large. The business depression, however, which resulted from the financial crisis of 1873, made, in course of time, its consequences felt in this as in all institutions of learning whose courses of study are more or less intimately connected with the development of the industrial resources of the country. The number of students fell off gradually, so that in 1879 there were only 177 reported in attendance. From this time, however, the number began steadily to increase. In presenting to the Legislature, their Nineteenth Annual Report, it is gratifying for the Governing Board to be able to say that the highest point ever before reached has now been passed. It is the more gratifying for them to make the announcement, because they are able to say at the same time that the recovery from this temporary depression has not been due in the slightest to any lowering of the requirements for admission or for graduation. Nor has the establishment of several other institutions of a similar nature throughout the country interfered either with the growth of this School or limited the field from which it draws its support. The table on page 13 shows that its students come from no particular locality, and that while in one sense it is an institution of this State, it attracts men from all quarters of the Union.

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Addition to the Corps of Professors.

The unexpected and sudden death of Professor Norton at the beginning of the academic year 1883–4 was mentioned in the last Annual Report. The department of Civil Engineering was left, in consequence, without a head. By great good fortune the Governing Board were at once enabled to secure the services of capable and experienced instructors, and a temporary arrangement was also made by which Professor DuBois was put in charge of the departments of both Civil and Mechanical Engineering. This was intended to continue only until the end of the last academic year, and during the course of it a satisfactory arrangement was reached, which it is believed will be productive of great permanent benefit to the School. Professor DuBois was at his own request transferred from the department of Dynamic to that of Civil Engineering, the latter being the one to which he had originally devoted himself. This left the former vacant. To fill this position the Governing Board have been fortunate enough to secure the services of Mr. Charles B. Richards, one of the best-known mechanical engineers in the country. Mr. Richards' life has been largely spent in positions connected with the great manufacturing establishments of the United States. From 1869 to 1880 he was the Engineering Superintendent of the Colt's Patent Fire Arms Manufacturing Company at Hartford, and from 1880 to 1884 he held the place of Superintendent of the Southwark Foundry and Machine Company at Philadelphia. Learning of his willingness to accept a call to this institution, he was at once recommended by the Governing Board to the professorship of Dynamic Engineering, and to that position he was elected by the Corporation of the College at their meeting on February 19, 1884. He entered upon his duties at the beginning of the present academic year.

As Professor Lyman had signified his desire to be relieved of a certain portion of his duties, the chair of Physics and Astronomy was at his suggestion divided, and an independent professorship of Physics created. To this Mr. Charles S. Hastings was elected at the meeting of the Corporation above mentioned, Professor Lyman retaining the department of Astronomy. Mr. Hastings was a member of the class of 1870 in the Scientific School. After receiving his degree of Bachelor of Philosophy he pursued a course of graduate study in physics and astronomy, obtaining in

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1873, from Yale College, the degree of Doctor of Philosophy. For the purpose of still further prosecuting his special studies, he went in 1873 to Europe, and spent two years in Germany and one in France. Returning to this country in 1875 he was made associate in Physics in Johns Hopkins University, and in 1882 was appointed associate Professor of Physics in the same institution. In 1883 he went to the Caroline Islands in charge of the spectroscopic observations of the eclipse of the sun which took place May 6, of that year, in the expedition sent out by the National Academy under Professor E. S. Holden. Resigning his professorship in Johns Hopkins University to accept the one established in this School, he likewise entered upon his duties at the beginning of the academic year.

Addition to the Laboratory of Physiological Chemistry.

It has been found advisable during the past year to give additional space to the laboratory of Physiological Chemistry. Increasing numbers of students in the biological course has rendered this step necessary, especially as it has seemed desirable to provide suitable accommodations for advanced work in this department of chemistry. A larger number of graduate students than ever before are engaged in research and it is to be hoped that with the present increased laboratory facilities still larger numbers may enter upon a course of advanced study in this department, which promises so much to students preparing for the medical profession.

The necessary space for a new laboratory, in a building already crowded, was to be found only by dismantling a former recitation room adjoining the old laboratory. This, however, has given a commodious and well lighted work room, quite well adapted to the purposes for which it is intended. The new laboratory has accommodations for twelve students in addition to the common space which necessarily forms an integral part of a well equipped laboratory. The additional room thus acquired gives to the biological course better advantages for successful work, and renders possible a more thorough study of many physiological problems.

It may be of interest in this connection to state that there are now in South Sheffield Hall but two recitation rooms remaining.

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One by one, as occasion has demanded, they have been converted into laboratories until now nearly the entire building is given up to the study of Chemistry in its various branches. This fact suggests that with increasing numbers of students in the School an additional building for chemistry will soon become an imperative necessity.

Additions to the Department of Physics.

The physical apparatus of the Sheffield Scientific School, though admirably adapted to the purposes of demonstration in the ordinary course of undergraduate lectures in most subjects, and even exceptionally rich in certain departments, was deficient in instruments for exact measurements, especially in the field of magnetism and electricity. To supply this defect the trustees appropriated a thousand dollars for the more immediate demands. This sum has been expended during the past year under the direction of the professor of physics. A large portion of the new apparatus was bought in Germany, but French manufacturers have contributed a part, and another portion has been designed by and constructed under the direction of the professor. This last course has been pursued only when satisfactory designs were lacking in the workshops of professional instrument-makers, or when the cost of such designs was excessive. It is believed that this plan and a fortuitously extensive acquaintance with the recent products of the leading instrument-makers of Europe, have rendered the purchases as economical as is consistent with perfect efficiency.

Among the more important additions may be named—

1. A reversible pendulum.
2. An electrical condenser for quantitative measurements, which can also be used for Volta's fundamental experiment.
3. A magnetometer.
4. An earth inductor.
5. A large universal galvanometer of a recent form, made by Hartmann, of Würtzburg.
6. A Wheatstone's bridge of the Kohlrausch form, by the same maker.
7. Two sets of resistance coils from 0.01 to 10,000 ohms.
8. Reading telescope and scales.
9. A quadrant electrometer, by Dr. Söhrer & Son, of Leipsic.
10. An ammeter.

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11. A magneto-electric machine of the Gramme form, by Breguet.

To these may be added a fine grating of about 45,000 lines on speculum metal, a gift to the institution from Professor Rowland, of the Johns Hopkins University; an accurate clock with electrical contact to make circuit every second, and, in process of construction, a grating spectroscope and a heliostat.

Besides the sum above named the School has devoted sufficient money to purchase and mount a dynamo machine and secondary battery of fifty cells. This machine, which is to provide electricity for all the laboratory and lecture-room experiments where strong currents are demanded, has already been ordered. It is to absorb two horse power of work. To drive it a four horse power engine is to be used which belongs to the department of Dynamical Engineering, the gift of Mr. Frank Bigelow. All of this last-mentioned apparatus will find a place in the room in the basement of the North Sheffield Hall which was formerly used by the Horological Bureau. The boiler which is to supply steam to the engine is also in part a gift from Messrs. Bigelow & Son, and is to be placed in the adjoining cellar near one of those used for heating the building.

Gifts.

The last annual Report announced that Dr. Beverley Livingston, of the class of 1874, had left to the School at his death his valuable scientific collections, consisting of books, journals, microscopic slides, and cryptogamous plants. From the same source a further gift has since been received. Mr. Francis A. Livingston, the father of the deceased, has presented to the permanent fund of the institution three thousand dollars, which had been accumulated by his son. This disposition of his property was made in accordance with the owner's request.

From the clerk of the Probate Court of the Plainfield district, the Governing Board has received an attested copy of part of the will of the Hon. David Gallup. The clause relating to the Sheffield Scientific School reads as follows:

"I give, devise and bequeath to the President and Fellows of Yale College one-fifth part of my said estate, and direct my executors to distribute the same to them if they accept it, on the following conditions, viz.: Said property shall be invested in a

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permanent fund to be known and called the David Gallup fund. The annual income of said fund shall be appropriated in paying the tuition of such young men residing in the State of Connecticut as shall be scholars in that department of said College known as the Sheffield Scientific School for a term of time not less than three months during the year, and who are not beneficiaries of the State in said department, and in case said income is not sufficient to pay the whole of said tuition, then it is to be apportioned to the payment of each scholar's tuition during the year whose attendance as a scholar in said school is in compliance with provisions herein expressed—as his attendance during said year bears to the whole attendance in said year under these provisions. And in case there shall be an excess in any year of the income of said fund over and above the tuition for the year, it shall be added to the principal of the fund until the principal is doubled, then any excess may be used for the benefit of said School."

In the last annual Report mention was also made of a gift of books to the library of the Scientific School by Professor Wolcott Gibbs, of Harvard University. The following is a catalogue of the works presented :

	No. Vols.
Smithsonian Reports for the years 1860, '70, '72, '76, '77	5
Petermann's Geographische Mittheilungen, 1855, '56, '57, '58, '59, '60, '61, '62, '63, '64, and Ergänzungsband for 1860–'61, 1862–'63, 1863–'64	13
Proceedings of the American Philosophical Society, Nos. 73, 81, 82, 84, 86, 88, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 112	27
List of Members	3
Bulletins of the Department of the Interior: Report of Entomological Commission, Nos. 3 and 6 (2 vols.)	3
Bulletins of the Survey of the Territories, Vol. II., Nos. 1, 2, 4; Vol. III., Nos. 1, 2, 3; Vol. IV., Nos. 1, 2; Vol. V., Nos. 1 (2 vols.), 2 (2 vols.), 3, 4; Vol. VI., Nos. 1, 2, 3; Miscellaneous Publications, No. 1 (2 vols.); Series II., 1, 6, Extract (Gannett on Contour Map)	22
Wheeler, Survey West of 100th Meridian, Part VI., Vol. III.	1
Wheeler, Annual Report on same, 1874, '75	2
Memoirs of the National Academy of Sciences	1
Gould, Catalogue of Stars, Extract from same	1
Annals of Harvard Observatory, Vol. IV., Part II.; Vols. VI., VII., IX., XI., Parts I., II.	6
Washington Astronomical Observations, 1868	1
United States Naval Astronomical Expedition, 1849–'52, and Appendix	2
Herschel, Astronomy	1
Desagerliers, A Course in Experimental Philosophy	3
Mousson, Physik	1

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	No. Vols.
Buff, Experimental Physik	1
Ruggles, Report on International Monetary Conference, 1867	1
——— Elements de Physique	2
Müller, Physik	1
Cooke, Chemical Physics	1
Miller, Elements of Chemistry	1
Löwig, Grundriss der Organischen Chemie	1
Knop, Chemische Methoden	1
Graham, Otto, Lehrbuch der Chemie	1
Limprichs, Lehrbuch der Organischen Chemie	1
Knapp, Lehrbuch der Chemischen Technologie	2
Physical Tracts	1
Technological Tracts	1
Chemical Tracts	4
Preisverzichniss	1
Mohl, Mikrographie	1
Brewster, Treatise on the Microscope	1
Bartlett, Optics and Acoustics	1
Bartlett, Analytical Mechanics	1
Schlömilch, Compendium der höheren Analyse	1
Hitchcock, Illustrations of Surface Geology	1
Indiana State Geological Report	1
Wetherill, Iron and Coal in Pennsylvania	1
Report of the Department of Agriculture, 1878	1
Sugar and Hydrometers	1
Inaugural Dissertations	1
Hospital Steward's Manual	1
Mordecai, Military Commission of Europe	1
Delafield, Art of War in Europe	1

Additions to the Zoological Collections.

A. E. Verrill, Curator.

The most important additions to the collections, as during several years past, have been due to the coöperation of the curator with the U. S. Fish Commission in the exploration of the deep sea off our coast. During the past summer the dredgings were carried on in the region of the Gulf Stream, from off Cape Hatteras to Cape Cod, and from shallow water to 2600 fathoms, by means of the steamer Albatross, Lieut. Z. L. Tanner commanding. The party was organized nearly as in 1883. Very large collections of Invertebrata were made, and the larger part were sent here for identification and description, as in previous years.

The curator has published during the year accounts of these and previous explorations in the American Journal of Science, in

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the Annual Report of the Fish Commission, and in Science. He has also published a detailed descriptive Catalogue of the deep-sea Mollusca, illustrated by several plates, in the Transactions of the Connecticut Academy. In this paper about 125 species are added to the fauna, a large part of them new.

Professor S. I. Smith has taken charge of the Crustacea, and has published in the Annual Report of the Fish Commission a report on the Crustacea dredged by the Albatross in 1883, and a shorter paper on the same subject in the American Journal of Science.

Mr. J. H. Emerton has published a paper on the New England spiders of the family Epeiridæ in the Transactions of the Connecticut Academy, with eight plates. He has also completed, for the museum, the model of the great California *Octopus*.

Miss K. J. Bush has continued the work of cataloguing and labeling the collections of shells, etc., dredged by the Fish Commission. She has also prepared for publication a list of the deep-sea shells dredged by the Fish Hawk, 1880 to 1882, and another on the shallow water shells dredged near Cape Hatteras in 1883.

Miss C. E. Bush has also been employed by the Fish Commission to work on the collections of Invertebrates in the museum.

The fishes of the Gulf of Mexico and South America have been worked up and returned by Professor D. F. Jordan and Mr. C. H. Gilbert. The results have been published in the Proceedings of the National Museum.

In addition to the collections dredged by the U. S. Fish Commission the following have been received:

Professor W. G. Mixter. Frog with but three legs, Iowa.

Dr. Street, New Haven. Young alligator.

W. E. Safford, U. S. N. Shells from China, etc. Hydroids from California.

Augustus Fifer, New Haven. Flounder with both sides pale, New Haven.

Professor J. D. Dana. A young seal, mounted.

R. Wells & Co., New Haven. Sea-fans and a very large, rare sea-urchin (*Metalia pectoralis*) from Nassau; and cuttlefishes from the Mediterranean.

A. H. Verrill, New Haven. An albino mole (*Scalops*) killed in Hamden by Mr. Warner. Nests of hornet, potter-wasp, etc.

Professor B. Silliman. A living lizard from Arizona.

H. S. Barnum. Skin of lynx from Turkey.

J. J. Rivers. Bryozoa from California.

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G. J. Brush. Young bat, in alcohol.

A. E. Verrill. Insects from Virginia, myriapods from Luray Cave.

Chas. H. Townsend, New Haven. Sections of a pile from long wharf, New Haven, bored by an unusual species of teredo (*Xylotrya fimbriata*). Young oysters showing rates of growth.

John B. Russell, Stony Creek. Orange file-fish and sea cat-fish.

A. H. Young, New Haven. Young skunk, living, East Haven.

Horace Bowman, New Haven. Fish and parasites, New Haven.

States Represented in the School.

The following table shows the States from which come the students whose names appear on the catalogue during the current year, and the proportion of numbers that belong to each.

	Graduates.	Seniors.	Juniors.	Freshmen.	Special.	Total.
1. California	--	1	3	--	1	5
2. Colorado	1	--	2	2	--	5
3. Connecticut	13	24	24	27	4	92
4. Dakota Territory	--	--	--	1	--	1
5. District of Columbia	--	--	1	1	--	2
6. Georgia	--	--	2	--	--	2
7. Illinois	--	3	6	6	--	15
8. Indiana	--	1	--	2	--	3
9. Kentucky	--	2	1	2	--	5
10. Maine	--	2	1	1	--	4
11. Massachusetts	--	--	--	2	--	2
12. Michigan	--	1	2	1	--	4
13. Minnesota	--	--	4	1	--	5
14. Missouri	--	4	2	--	--	6
15. Nebraska	--	1	2	2	--	5
16. New Jersey	1	1	1	1	--	4
17. New York	4	18	9	19	2	52
18. Ohio	1	4	3	4	2	14
19. Oregon	--	1	--	--	--	1
20. Pennsylvania	--	6	4	7	--	17
21. Rhode Island	--	--	1	--	--	1
22. Texas	--	--	1	1	--	2
23. Vermont	--	--	1	--	--	1
24. Wisconsin	--	--	1	--	--	1
25. Saxony, Germany	--	--	--	1	--	1
Total	20	69	71	81	9	250

To a certain extent these statistics are deceptive. Connecticut has always a large number added to what belongs to it legiti-

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mately, from the fact that families come here from other States and take up a temporary residence for the sake of educating their children. Graduate students also frequently change their residences to New Haven.

Public Lectures.

The annual course of lectures to mechanics and others has been given during the past year. The lectures and their subjects are indicated in the annexed programme:

I. Tuesday, Feb. 26.—The Relation of Literature to Life. Mr. Charles Dudley Warner
II. Thursday, " 28.—Sunflowers and Kindred Plants. Prof. Daniel C. Eaton
III. Tuesday, March 4.—The Mormons and their Country. Prof. Brewer
IV. Thursday, " 6.—The Mormons and their Country. Prof. Brewer
V. Tuesday, " 11.—The Resources of Mexico. Mr. Alfred R. Conkling
VI. Thursday, " 13.—The Railroad Problem. Mr. Arthur T. Hadley
VII. Tuesday, " 18.—Muscles and Nerves. Prof. Chittenden
VIII. Thursday, " 20.—The Art of Seeing. Prof. Niemeyer
IX. Tuesday, " 25.—Science among the Arabians. Rev. Edward Hungerford
X. Thursday, " 27.—Flying and Flying Machines. Mr. Thomas W. Mather
XI. Tuesday, April 1.—Chemical Affinity. Prof. Johnson
XII. Thursday, " 3.—Earthquakes and Volcanoes. Prof. Verrill

Lectures on Military Science.

A course of Lectures on Military Science, by officers of the U. S. Engineering School at Willets Point, was delivered in North Sheffield Hall as a part of the instruction in the School during the second term of the academic year 1883–84.

The order and subjects of the Lectures were as follows:

I. Monday, Feb. 25.—Strategy and Grand Tactics. 1st Lieut. James G. Warren, U. S. Engineers
II. Friday, " 29.—Logistics. 1st Lieut. James L. Lusk, U. S. Engineers
III. Monday, March 3.—Small Arms and their Influence on Tactics. 1st Lieut. Harry F. Hodges, U. S. Engineers
IV. Friday, " 7.—Artillery. 1st Lieut. John Biddle, U. S. Engineers
V. Monday, " 10.—Fortification. Capt. J. H. Willard, U. S. Engineers
VI. Friday, " 14.—Sea Coast Defense. Gen. H. L. Abbot, U. S. Engineers

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Anniversary.

The Exercises of the Graduating Class were held in North Sheffield Hall on the evening of Tuesday, June 24, 1884. The candidates for degrees with the subjects of the graduation theses of the Bachelors of Philosophy are given in the following schedule. The names in the first list are of those who stood highest in their respective courses. Those marked with an asterisk read theses in the evening.

Dynamic Engineer.

Herbert Waldron Faulkner, *Stamford.* Steam Launch Calculations.

Bachelors of Philosophy. (13.)

*Lawrence Vincent Benét (Civil Engineering), *Washington, D. C.* Review of the Michigan and New York Central Bridge over the Niagara River.

Edward Blake (Dynamic Engineering), *New Haven.* On the Prevention of Induction in Telephone Wires.

*Chauncey Rea Burr (Select), *Portland, Me.* On the Irish Land Law of 1881.

Herbert DeWitt Carrington (Civil Engineering), *New Haven.* On the Theory of the Stone Arch.

Louis Edward Cooper (Biology), *Ansonia.* On the Kidney of the Cat.

*George Wyckoff Cummins (Biology), *Vienna, N. J.* On the Digestibility of Fish Flesh.

*Charles Percival Farquhar (Dynamic Engineering), *York, Pa.* On the System of Rapid Transit in New York.

*Calvin Linsley Harrison (Biology), *New Haven.* On the Exoskeleton of *Platyonichus ocellatus.*

*Edward Musser Herr (Dynamic Engineering), *Denver, Col.* On the Block, and Interlocking Railroad Signals.

James Henry Jennings (Civil Engineering), *Redding.* On the Construction and Maintenance of Highways and Pavements.

*Albert Lucas (Chemistry), *Philadelphia, Pa.* On Eosin.

*William Wallace Nichols (Dynamic Engineering), *Manitou Springs, Col.* On the Compound Engine with an original Design for a Compound Yacht Engine.

*Herbert Lincoln Noyes (Chemistry), *New Haven.* On a Short Method of Separating a Small Amount of Zinc from a Large Excess of Iron.

*William Tuttle Shepard (Civil Engineering), *Bristol.* On the Sinking of Foundations by the Use of Compressed Air.

James Henry Warner (Select), *Steubenville, O.* On Methods of Conducting Presidential Elections.

Andrew Lincoln Winton (Chemistry), *Bridgeport.* On the Chemical Composition of a Mineral from Fowler, N. Y.

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GUSTAVO ALFONSO (Chemistry), *New York City.* On the Separation of Zinc and Nickel.

ELWOOD HARVEY ALLCUTT (Dynamic Engineering), *Kansas City, Mo.* On the Edison System of Incandescent Lighting.

ALBERT PARK CAMPBELL (Dynamic Engineering), *New Haven.* On the Theory of the Giffard Injector.

WILLIAM BRAINARD COIT (Select), *New London.* On the United States Weather Signal Service.

CLIFFORD LAURENCE COLTON (Civil Engineering), *Canton.* Review of the Chapel Street Bridge over West River.

ARTHUR BIXBY FERGUSON (Biology), *New Haven.* On the Nervous System of the Cat.

DAVENPORT GALBRAITH (Select), *Erie, Pa.* On Criminal Procedure in the United States and France.

MORGAN AUGUSTUS GUINNIP (Select), *Washington, D. C.* On the Silk Industry of the United States.

JOHN BELL HATCHER (Natural History). *Cooper, Iowa.* On the Genus of Mosses termed *Conomitrium.*

SAMUEL BROWN HAWLEY (Dynamic Engineering), *Yonkers, N. Y.* On Electric Lighting.

HENRY CLAY JOHNSON (Dynamic Engineering), *Rome, Ga.* On the Westinghouse Automatic Engine.

THOMAS CROSSLEY JOHNSON (Dynamic Engineering), *New Haven.* On the Manufacture of Iron and Steel.

EDSON KEITH, JR. (Dynamic Engineering). *Chicago, Ill.* On the Telephone.

DUANE JUDSON KELSEY (Dynamic Engineering), *Killingworth.* On the Transmission of Energy.

LUTHER JAMES MARTIN (Biology), *Norwich.* On the Vertebral Column, the Shoulder and Pelvic Girdles of the Cat.

GEORGE EDGAR MOULTHROP (Civil Engineering), *New Haven.* On the Niagara Falls Suspension Bridge.

ALBERT ANDERSON NOYE (Dynamic Engineering), *Buffalo, N. Y.* On Roller Mills.

JOSEPH POWELL, JR. (Civil Engineering), *Towanda, Pa.* On the Sewerage and Sewage Systems.

JOSEPH WARREN ROGERS, JR. (Dynamic Engineering), *Scarborough, N. Y.* On the Theory of the Dynamo-Electric Engine.

WALTER ALLEN SADD (Civil Engineering), *South Windsor.* On the Ventilation of Public Buildings.

WILLIAM GODFREY SAGE (Dynamic Engineering), *Chicago, Ill.* On Hydraulic Elevators.

RUSSELL SARGENT (Chemistry), *New Haven.* On the Incrustations of Boilers.

CLARENCE WELLINGTON SHELDON (Biology), *Brooklyn, N. Y.* On the Skull of the Cat.

JOHN PRENTICE TERRY (Dynamic Engineering), *Brooklyn, N. Y.* On Turbine Water Wheels.

CHESTER THORNE (Civil Engineering), *Millbrook, N. Y.* On the Improved Main Drainage System of Boston.

ELMORE ABRAM WILLETS (Select), *Belmont, N. Y.* On the Production of Crude Petroleum.

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FRANKLIN ELDRED WORCESTER, A.B. (Dynamic Engineering), *Albany, N. Y.* On the Steam Indicator.

PRIZES.

CLASS OF 1884.

For excellence in *Civil Engineering*, the prize awarded to LAURENCE VINCENT BENÉT, *Washington, D. C.*

For excellence in *Dynamic Engineering*, the prize awarded to EDWIN MUSSER HERR, *Denver, Col.*, with honorable mention of CHARLES PERCIVAL FARQUAR, *York, Pa.*, and WM. WALLACE NICHOLS, *Manitou Springs, Col.*

For excellence in *German*, the prize divided between GEORGE WYCKOFF CUMMINS, *Vienna, N. J.*, and CHARLES PERCIVAL FARQUAR, *York, Pa.*

CLASS OF 1885.

For excellence in the *Mathematics of Junior Year*, the prize divided between JAMES ALWARD SEYMOUR, *Auburn, N. Y.*, and FREDERICK BREWSTER WHEELER, *Monroe*, with honorable mention of ROBERT NEILL BRACE, *Dobbs Ferry, N. Y.*, JOHN VENABLE HANNA, *Kansas City, Mo.*, and LOUIS MILTON SCHMIDT, *New Britain.*

CLASS OF 1886.

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For excellence in *German*, the prize divided between EMANUEL FRANK SELZ and EDWIN FRANK MEYER, *Chicago, Ill.*

For excellence in *Mathematics*, the prize divided between HARRIE SHELDON LEONARD, *Washington, D. C.*, and WILLIAM SANDERS TEVIS, *San Francisco, Cal.*

For excellence in *Physics*, the prize awarded to THEODORE NEWTON CASE, *Hartford.*

For excellence in *Chemistry*, the prize awarded to WILLIAM SANDERS TEVIS, *San Francisco, Cal.*

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PROGRAMME OF STUDIES

AND

CATALOGUE,

FOR THE COLLEGE YEAR, 1884-85.

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CALENDAR.

1884.		
18 Sept.	Thursday,	First Term begins.
22 Dec.	Monday,	First Term ends.
1885.		**Winter Vacation of two weeks.**
6 Jan.	Tuesday,	Second Term begins.
1 April,	Wednesday,	Spring Recess begins.
8 April,	Wednesday,	Spring Recess ends.
23 June,	Tuesday,	Meeting of Appointing Board.
23 June,	Tuesday,	Anniversary.
24 June,	Wednesday,	Commencement.
25, 26, 27 June	Thursday, Friday, Sat.,	Examination for Admission.
		Summer Vacation of thirteen weeks.
22, 23 Sept.	Tues., Wedn.,	Examination for Admission.
24 Sept.	Thursday,	First Term begins.
24 Dec.	Thursday,	First Term ends.

ABBREVIATIONS.

S. H.	Sheffield Hall.
N. S. H.	North Sheffield Hall.
TR.	Treasury Building.
D.	Durfee College.
F.	Farnam College.
E.	East Divinity Hall.
W.	West Divinity Hall.
P. M.	Peabody Museum.
A.	Absent on leave.

In the buildings belonging to the Sheffield Scientific School, the rooms numbered from 1 to 21 are in Sheffield Hall; from 26 to 58 in North Sheffield Hall.

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Henry William Blake,	*New Haven*,	361 Temple st.
John Marvin Blakeley,	*St. Paul, Minn.*,	389 Temple st.
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Percival Ranney Bolton,	*Cleveland, O.*,	55 W.
Louis Whitford Bond,	*New York City*,	61 W.
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Harry Lockwood Burns,	*Milford*,	63 Prospect st.
Lewis Emerson Cadwell,	*New Haven*,	106 Liberty st.
Fred. Eaton Case,	*Detroit, Mich.*,	389 Temple st.
Theodore Newton Case,	*Hartford*,	287 York st.
John Chamberlain,	*Kansas City, Mo.*,	76 Mansfield st.
Frederick William Darlington,	*West Chester, Pa.*,	133 College st.
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Cornelius Fay Lynde,	*Rock Island, Ill.*,	90 Wall st.
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Alexander Holley Rudd,	*Lakeville*,	389 Temple st.
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Emanuel Frank Selz,	*Chicago, Ill.*,	126 High st.
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William Sanders Tevis,	*San Francisco, Cal.*,	36 Elm st.
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James Edward Warnock,	*Atlanta, Ga.*,	126 High st.
Charles Willcox,	*Omaha, Nebr.*,	163 Temple st.
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Willis Stoughton Williams,	*Minneapolis, Minn.*,	389 Temple st.
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Emerson Francis Bennett,	*Pueblo, Col.*,	347 York st.
Walter Pierpont Bigelow,	*New Haven*,	278 Orange st.
Herbert Spencer Bullard,	*Hartford*,	397 Temple st.
Lewis Alexander Burgess,	*Newark, N. J.*,	59 Prospect st.
William Harper Butler,	*Olean, N. Y.*,	64 High st.
George Alfred Caldwell,	*Louisville, Ky.*,	395 Temple st.
Richard Augustus Chapman,	*Rye, N. Y.*,	150 College st.
Harry Fitch Coleman,	*Logansport, Ind.*,	295 Temple st.
Lewis Atterbury Conner,	*New Albany, Ind.*,	59 Prospect st.
David Mark Cummings,	*Chicago, Ill.*,	391 Temple st.
Julius Gilbert Day,	*Seymour*,	205 Orange st.
William Greenhow Doane,	*Omaha, Nebr.*,	159 York st.
John Ambrose Doolittle,	*New Haven*,	219 Orange st.
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Francis Frederic Georger,	*New York City*,	155 Elm st.
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Charles Joseph Goldmark,	*New York City*,	629 Chapel st.
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Harry Leon Hamlin,	*Chicago, Ill.*,	1179 Chapel st.
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William Lynde Harrison,	*New Haven*,	39 College st.
Herbert Leopold Hart,	*Chicago, Ill.*,	38 High st.
James Henry Hayden,	*New York City*,	55 Trumbull st.
Henry Allen Higley, Jr.,	*Brooklyn, N. Y.*,	238 York st.
Joseph Cooke Jackson, Jr.,	*New York City*,	113 College st.
Lawrence Bates Jenckes,	*Stamford*,	109 Elm st.
Leonard Abbot Jenkins,	*Dresden, Saxony*,	124 High st.
Charles Sherman Jewett,	*Buffalo, N. Y.*,	136 College st.
John Edwin Judson,	*New Haven*,	142 St. John st.
Frederick Sheffield Kellogg,	*Utica, N. Y.*,	55 Trumbull st.
Charles Foster Kent,	*Palmyra, N. Y.*,	364 George st.
Grayson Guthrie Knapp,	*Auburn, N. Y.*,	391 Temple st.
Charles Wilbur Knox,	*Pittsburgh, Pa.*,	155 Elm st.

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John Stewart Kulp,	*Wilkesbarre, Pa.*,	242 York st.
Isaac Eugene Leonard,	*Chicago, Ill.*,	64 High st.
Edward Linsley Maltby,	*Northford*,	297 York st.
Harry Zeller Marshall,	*Dayton, O.*,	61 Grove st.
Harley James Morrison,	*Cincinnati, O.*,	129 College st.
Samuel Everett Oakes,	*Washington, D. C.*,	36 Elm st.
William Partridge Ordway,	*Boston, Mass.*,	155 Elm st.
Edward Horatio Parker,	*Detroit, Mich.*,	395 Temple st.
Franklin Treat Parlin,	*Casselton, Dakota*,	8 Prospect pl.
John Erskine Patrick,	*Omaha, Nebr.*,	159 York st.
David Walter Patten,	*North Haven*,	119 Greene st.
Edmund Bishop Patterson,	*Allegheny City, Pa.*,	381 Crown st.
Frank Adelbert Paul,	*New Haven*,	27 Washington st.
Charles Eugene Phillips,	*Southington*,	53 Prospect st.
William Thomas Rainey	*Cleveland, O.*,	237 Orange st.
Frank Clark Reed,	*Pittsburgh, Pa.*,	203 York st.
Harris Smith Reynolds,	*Poughkeepsie, N. Y.*,	55 Trumbull st.
George Brinckerhoff Richards,	*New Haven*,	43 Elm st.
John Robert Wheaton Sargent,	*Chicago, Ill.*,	120 York st.
William Marcelin Scaife,	*Allegheny City, Pa.*,	203 York st.
Oscar Harmon Short,	*New York City*,	39 Lynwood st.
Edward Arthur Smith,	*Middletown*,	508 Chapel st.
Frink Mansfield Smith,	*East Haven*,	East Haven
Erwin Starr Sperry,	*Ansonia*,	41 High st.
Daniel Perry Stanton,	*New York City*,	393 Temple st.
Merton Pierpont Stevens,	*New Haven*,	522 Howard av.
Arthur Peale Summers,	*Colorado Springs, Col.*,	126 High st.
Louis Denio Tourtellot,	*Utica, N. Y.*,	43 College st.
William Conquest Tucker,	*New York City*,	629 Chapel st.
Howard Beecher Tuttle,	*Naugatuck*,	242 York st.
Donald Robertson Tyler,	*Owensboro, Ky.*,	242 York st.
Alfred John Wakeman,	*Green's Farms*,	53 Prospect st.
Frank Otto Walther,	*Brooklyn, N. Y.*,	53 Prospect st.
Nathaniel P. Washburn,	*Bridgewater, Mass.*,	53 Prospect st.
Frank Warren Wentworth,	*Chicago, Ill.*,	161 York st.
Edward Gilbert Williams,	*Essex*,	17 Wooster pl.
George Henry Wood,	*Dayton, O.*,	61 Grove st.

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SPECIAL STUDENTS NOT CANDIDATES FOR A DEGREE.

Samuel Ellsworth Allen,	*Glendale, O.*,	126 High st.
Silas Enoch Burrows,	*Mystic*,	14 Lincoln st.
Wallace Arthur Butricks,	*New Haven*,	300 Columbus av.
John Cerow Dutcher,	*Pawling, N. Y.*,	90 Wall st.
Ludwig Otterson Kellogg,	*San Francisco, Cal.*,	421 Temple st.
Benjamin I. Smith,	*Sherburne, N. Y.*,	17 College st.
Francis Timothy Smith,	*Simsbury*,	7 Pearl st.
Warren A. Spalding,	*New Haven*,	89 Church st.
Francis Lewis Sperry,	*Tallmadge, O.*,	146 College st.

SUMMARY.

Graduates,	20
Seniors,	69
Juniors,	70
Freshmen,	81
Special,	10
Total,	250

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SHEFFIELD SCIENTIFIC SCHOOL.

I.

OBJECTS.

The Sheffield Scientific School is devoted to instruction and researches in the mathematical, physical, and natural sciences, with reference to the promotion and diffusion of science, and also to the preparation of young men for such pursuits as require especial proficiency in these departments of learning. It is one of the Departments of Yale College, like the law, medical, theological, and art schools, having its separate funds, buildings, teachers, and regulations, but governed by the Corporation of Yale College, which appoints the professors and confers the degrees. It is, in part, analogous to the academic department, or classical college, and, in part, to the professional schools.

The instruction is intended for two classes of students :—

I. Graduates of this or of other Colleges, and other persons qualified for advanced or special scientific study.

II. Undergraduates who desire a training chiefly mathematical and scientific, in less part linguistic and literary, for higher scientific studies, or for various other occupations to which such training is suited.

II.

HISTORY AND ORGANIZATION.

The School was commenced in 1847. In 1860, a convenient building and a considerable endowment were given by Joseph E. Sheffield, Esq., of New Haven, whose name, at the repeated request of the Corporation of Yale College, was afterward attached to the foundation. Mr. Sheffield afterward frequently and munificently increased his original gifts.

In 1863, by an act of the Connecticut Legislature, the national grant for the promotion of scientific education (under the congressional enactment of July, 1862) was given to this department

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of Yale College. Since that time, and especially since the autumn of 1869, numerous liberal gifts have been received from the citizens of New Haven, and from other gentlemen in Connecticut, New York, and St. Louis, for the endowment of the School, and the increase of its collections.

The action of the State led to the designation by law of a State Board of Visitors, consisting of the Governor, Lieutenant-Governor, three senior Senators, and the Secretary of the State Board of Education: and this Board, with the Secretary of the Scientific School, is also the Board for the appointment of students to hold the State scholarships.

The Governing Board consists of the President of Yale College and the Professors who are permanently attached to the School. There are several other instructors associated with them, a part of whom are connected with other departments of the College.

III.

BUILDINGS AND APPARATUS.

The two buildings in which the work of instruction in the Scientific School is mainly carried on are called Sheffield Hall and North Sheffield Hall; but instruction in Mineralogy, Geology, and Biology, including Zoölogy and Comparative Anatomy, is now given entirely in the Peabody Museum. These buildings contain a large number of recitation and lecture rooms, a hall for public assemblies and lectures, chemical and metallurgical laboratories, a photographical room, an astronomical observatory, museums, a library and reading room, besides studies for some of the professors, where their private technical libraries are kept.

The following is a summary statement of the collections belonging to the School:

1. Laboratories and Apparatus in Chemistry, Metallurgy, Physics, Photography, and Zoölogy.
2. Metallurgical Museum of Ores, Furnace Products, etc.
3. Agricultural Museum of Soils, Fertilizers, useful and injurious insects, etc.
4. Collections in Zoölogy.
5. Astronomical Observatory, with an equatorial telescope by Clark and Sons of Cambridge, a meridian circle, etc.
6. A Collection of Mechanical Apparatus, constituting the "Collier Cabinet."
7. Models in Architecture, Geometrical Drawing, Civil Engineering, Topographical Engineering and Mechanics; diagrams adapted to public lectures; instruments for field practice.

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8. Maps and Charts, topographical, geological, hydrographical, etc.

The herbarium of Professor Brewer, and the astronomical instruments of Professor Lyman, are deposited in the buildings. Professor Eaton's herbarium, near at hand, is freely accessible. Students also have access to the various laboratories and collections in Natural Science in the Peabody Museum.

Students are also admitted, under varying conditions, to the College and Society libraries, the College Reading Room, the School of the Fine Arts, and the Gymnasium.

IV.

THE LIBRARY.

The special technical library of the Scientific School consists of about five thousand volumes. Included in this is the "Hillhouse Mathematical Library" of twenty-four hundred volumes, collected during a long series of years by Dr. William Hillhouse, and in 1870 purchased and presented to the Institution by Mr. Sheffield. A catalogue of this collection forms a supplement to the Annual Report of the Governing Board for 1870. All the prominent scientific journals of this country and of Europe, together with the proceedings of foreign academies, and scientific societies, can be found either in this library or in the College Library to which students have access.

V.

INSTRUCTION FOR GRADUATE AND SPECIAL STUDENTS.

Persons who have gone through undergraduate courses of study, here or elsewhere, may avail themselves of the facilities of the School for more special professional training in the physical sciences and their applications, gaining in one, two, or three years the degree of Bachelor of Philosophy, or, in two additional years of Engineering study, that of Civil Engineer, or of Dynamic Engineer.

Or, engaging in studies of a less exclusively technical character, they may become candidates for the degree of Doctor of Philosophy. The instruction in such cases will be adapted to the particular needs and capacities of each student, and may be combined with that given by the graduate instructors in other departments of the University. This degree is conferred upon those who, having already taken a Bachelor's degree, engage as students in the

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Department of Philosophy and the Arts for not less than two years in assiduous and successful study. It is not given upon examination to those whose studies are pursued elsewhere. The requirements for it will in some cases exact of the student more than two years of post-graduate labor; so, especially, wherever the course of nndergraduate study has been, as in the Scientific School, of less than four years. The candidate must pass a satisfactory final examination, and present a thesis giving evidence of high attainment in the branches of knowledge to which he has attended. A good knowledge of Latin, German and French will be required in all cases, unless, for some exceptional reason, the candidate be excused by the Faculty. The graduating fee is ten dollars.

Subjects likely to receive special attention are suggested as follows:

Professor LYMAN, in the use of meridional and other astronomical instruments.

Professor DUBOIS, in the principles of thermodynamics, and utilization of heat as a source of power.

Professor RICHARDS, in dynamical engineering.

Professor HASTINGS, in selected topics in physics, and guidance in laboratory work.

Professor Brush, in the analysis and determination of mineral species, and in descriptive mineralogy.

Professor JOHNSON, in theoretical, analytical, and agricultural chemistry.

Professor BREWER, in agriculture and forest culture, in the use of the microscope, and in physical geography.

Professor CLARK, in definite integrals, differential equations, analytical mechanics, the theory of numerical approximation, with the method of least squares.

Professor EATON, in structural and systematic botany, with reference to both flowering and cryptogamous plants.

Professor ALLEN, in analytical chemistry, and in metallurgy.

Professor VERRILL, and Professor SMITH, in zoölogy and geology.

Professor CHITTENDEN, in physiological chemistry.

The same courses of study are open, for a longer or shorter time, to graduate students who do not desire to become candidates for a degree.

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Students who have taken the degree of Bachelor of Philosophy, may obtain the degree of CIVIL or of DYNAMIC ENGINEER at the end of two academical years, by pursuing the following higher course of study and professional training.

The course of study for the degree of CIVIL ENGINEER will comprise—

1. Higher Calculus. Higher Geometry. Theory of Numerical Operations.
2. Analytical Mechanics. Mechanics applied to Engineering.
3. A Course of Construction and Design. Projects.
4. Practical Astronomy, with use of instruments, computations, etc.

This course will occupy one year.

To secure the requisite amount of professional knowledge and practice, the candidate will be required to furnish a comprehensive report of the results of an examination into the existing condition of some special line of constructive art; or to present proper evidence that he has had actual charge in the field, for several months, of construction or surveying parties, or held some responsible position deemed equivalent to this.

An elaborate design must also be submitted of some projected work of construction, based upon exact data obtained from careful surveys made by the candidate, and comprising all the requisite calculations, and the necessary detailed drawings, and accompanied by full specifications of the work to be done, and the requirements to be met by the contractor.

The fee for this degree is five dollars.

The course of study for the degree of DYNAMIC ENGINEER will comprise—

1. Higher Calculus. Higher Geometry. Theory of Numerical Operations.
2. General Principles of Dynamics (Analytical Mechanics), including special application of these Principles to Dynamic problems.
3. Construction of Machines. Designs.
4. Preparation of theses on special subjects in Dynamic Engineering.

During the second year candidates will be permitted to employ such a portion of their time as may be deemed advisable or necessary in the examination of engineering works and manufacturing establishments, and may also have the privilege of entering upon professional practice, provided it is done with the knowledge and consent of the Professor of Dynamic Engineering, and under such circumstances as shall appear to him to be favorable to professional progress.

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An elaborate thesis on some professional subject, with an original design, or project, accompanied by proper working drawings, will be required at the end of the second year.

The fee for this degree is five dollars.

SPECIAL STUDENTS.—For the benefit of those who, being fully qualified, desire to pursue particular studies without reference to the obtaining of a degree, special or irregular students are received in most of the departments of the School: not, however, in the Select Course or in the Freshman Class.

It should be distinctly understood that these opportunities are not offered to persons who are incompetent to go on with regular courses, but are designed to aid those who, having received a sufficient preliminary education elsewhere, desire to increase their proficiency in special branches.

VI.

REQUIREMENTS FOR ADMISSION AND COURSES OF INSTRUCTION FOR UNDERGRADUATE STUDENTS.

TERMS OF ADMISSION.—Candidates must not be less than fifteen years of age, and must bring satisfactory testimonials of moral character from their former instructors or other responsible persons.

For admission to the Freshman Class the student must pass a thorough examination in the following subjects:

English—including grammar, spelling and composition. In grammar, Whitney's Essentials of English Grammar, or an equivalent.

History of the United States.

Geography.

Latin—(1) Simple exercises in translating English into Latin. (Smith's "*Principia Latina*," Part I, is named as indicating the nature and extent of this requirement, and an acquaintance with it will be required unless a satisfactory substitute is offered). (2) Cæsar—six books of the Gallic War, or their equivalent. (As advantageous substitutes for the last three books of Cæsar may be suggested three books of Vergil's Æneid or a similar amount of Ovid.)

Arithmetic—Fundamental Operations, Least Common Multiple, Greatest Common Divisor, Common and Decimal Fractions, Denominate Numbers, including the Metric System of Weights and Measures; Percentages, including Interest, Discount, and Commission; Proportion, Extraction of the Square and Cube Roots.

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Algebra—Fundamental Operations, Fractions, Equations of the First Degree with one or several unknown quantities; Inequalities, Ratio and Proportion, Involution, including the Binomial Formula for an entire and positive Exponent; Evolution, the Reduction of Radicals, Equations of the Second Degree, Progressions, Permutations and Combinations, the Method of Indeterminate Coefficients, Fundamental Properties of Logarithms, Compound Interest.

Geometry—Plane, Solid and Spherical; including fundamental notions of Symmetry, and examples of Loci and Maxima and Minima of Plane Figures.

Trigonometry—Including the Analytical Theory of the Trigonometrical Functions, and the usual formulæ; the Construction and Use of Trigonometrical Tables; and the Solution of Plane Triangles; so much, for example, as is contained in Newcomb's Trigonometry to Art. 79, or in Wheeler's, or Richards's, or Wentworth's Plane Trigonometry. The Logarithmic and Trigonometric Tables furnished at the Examination will be Newcomb's (Henry Holt & Co., New York, 1882).

While no entrance examination is held in the *History of England*, candidates for admission are urgently advised to make themselves as familiar as possible with that subject; as a knowledge of it is essential to the most successful prosecution of some of the studies of the course.

Candidates will be allowed the option of passing on the above-named subjects in two successive years. In such cases they must present themselves for examination at the June examination of the first year in the following subjects or parts of subjects: *History of the United States, Geography, Arithmetic, Plane Geometry, and Algebra to Quadratic Equations.*

In order to have this preliminary examination counted, candidates must pass satisfactorily on four of the subjects; and notice of the intention to divide the examination must be given to Professor G. J. Brush, Director of the School, on or before June 15.

For preparation in Algebra, Geometry, and Trigonometry, the recently published text-books of Professor Newcomb (Henry Holt & Co., New York), may, without indicating undue preference, be especially recommended. And to the candidate who prepares in other works, they may serve to indicate the extent and kind of attainments expected in the prescribed topics. Candidates who prepare in the Geometry of this author, may for the present omit the short chapters on Ellipse, Hyperbola, and Parabola; though they will find it advantageous to study them.

In his preparation in GEOMETRY the candidate should, as far as practicable, have suitable exercises in proving simple theorems and solving simple problems for himself. It is important, too, that he should be accustomed to the numerical application of geometric principles, and especially to the prompt recollection and use of the elementary formulæ of mensuration. In TRIGONOMETRY he should be exercised in applying the usual formulæ to a variety of simple reductions and transformations, including the solution of trigonometrical equations. Readiness and accuracy in trigonometrical calculations are also of prime importance to the candidate. If the use of logarithms is postponed in his preparation till Trigo-

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nometry is taken up (which is by no means necessary or advisable), he should then have abundant applications of them to all forms of calculation occurring in ordinary practice, as well as to those appearing in the soultion of triangles. Finally in all of his calculations. he should study the art of neat and orderly arrangement.

In LATIN the student should have such continued training in parsing as shall make him thoroughly familiar with declensions and conjugations, and with the leading principles of Syntax. To secure these results more effectually, the requirement has been adopted of simple exercises in translating English into Latin. As this course of exercises is designed solely as a preparation for reading, it should be begun at the earliest stage of Latin study. A very large proportion of the deficiencies in the Latin examination for several years past has been due to the neglect of the suggestions of this paragraph, and to the attempt to read a Latin author with totally inadequate grammatical preparation.

The examinations for admission in 1885, take place at North Sheffield Hall, on Thursday, Friday, and Saturday, June 25, 26, 27 (beginning at 9 A. M. on Thursday); and on Tuesday and Wednesday, September 22, 23 (beginning at 9 A. M. on Tuesday). Opportunities for private examinations may, in exceptional cases, be given at other times.

In 1885 examinations (for the Freshman Class only) will also be held in Andover, Mass., in Chicago, in Cincinnati, and in San Francisco (beginning on Thursday, June 25, at 9 A. M.), at places to be announced in local newspapers of the day previous. Candidates who propose to be present are requested to send their names to Professor G. J. Brush, Director of the School, before June 15. A fee of five dollars will be charged for admission to the examinations outside of New Haven.

Candidates for advanced standing in the undergraduate classes are examined, in addition to the preparatory studies, in those already pursued by the class they wish to enter. No one can be admitted as a candidate for a degree, later than at the beginning of the Senior year.

COURSES OF INSTRUCTION, occupying three years, are arranged to suit the requirements of various classes of students. The first year's work is the same for all; for the last two years the instruction is chiefly arranged in special courses.

The special courses most distinctly marked out are the following:

(*a.*) In Chemistry; (*b.*) In Civil Engineering;
(*c.*) In Dynamical (or Mechanical) Engineering;
(*d.*) In Agriculture; (*e.*) In Natural History;
(*f.*) In Biology preparatory to Medical Studies;
(*g.*) In studies preparatory to Mining and Metallurgy;
(*h.*) In select studies preparatory to other higher studies.

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The arrangement of the studies is indicated in the annexed scheme.

FRESHMAN YEAR—INTRODUCTORY TO ALL THE COURSES:

FIRST TERM—*German*—Whitney's Grammar and Reader. *English*—Lounsbury's History of the English Language; Exercises in composition. *Mathematics*—Spherical Trigonometry (Newcomb's); Plane Analytical Geometry. *Physics*—Recitations, with experimental lectures. *Chemistry*—Recitations and Laboratory practice. *Elementary Drawing*—Practical Lessons, in the Art School.

SECOND TERM—*Language, Physics and Chemistry*—as stated above. *Mathematics*—Plane Analytical Geometry, continued. *Physical Geography*—Lectures. *Botany*—Gray's Lessons, with Lectures. *Drawing*—Isometric Drawing, with application to drawing from models and structures by measurement. Shading and tinting. Principles of orthographic projection. Reading of working-drawings and isometric construction of objects from their orthographic projections. Sections.

For the Junior and Senior years the students select for themselves one of the following Courses:

(a.) IN CHEMISTRY:

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. *Qualitative Analysis* — Fresenius's. *Laboratory Practice. Blowpipe Analysis. German. French.*

SECOND TERM — *Theoretical Chemistry* — continued. *Laboratory Practice*—Quantitative Analysis, and experimental work in Organic Chemistry. *Mineralogy*—Blowpipe Analysis and determination of species. Lectures. *French. German.*

SENIOR YEAR:

FIRST TERM—*Organic Chemistry* — Lectures and Recitations. *Agricultural Chemistry*—Recitations (optional). *Laboratory Practice*—Volumetric and Mineral Analysis. *Geology*—Dana's. *Zoology*—Lectures. *French.*

SECOND TERM—*Organic Chemistry*—continued. *Laboratory Practice*—Analysis of Minerals and Technical Products. *Assaying* (optional). *Geology*—Dana's. *Mineralogy* (optional). *French.*

(b.) IN CIVIL ENGINEERING:

JUNIOR YEAR:

FIRST TERM—*Mathematics*—Analytical Geometry of three Dimensions; Elements of the Theory of Functions; Differential Calculus. *Surveying*—Field Operations. *Drawing*—Descriptive Geometry, begun. *German. French.*

SECOND TERM—*Mathematics*—Integral Calculus; Rational Mechanics. *Drawing*—Descriptive Geometry, concluded; Topographical. *Surveying*—Topographical. *German. French.*

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SENIOR YEAR:

FIRST TERM—*Field Engineering*—Laying out Curves. Location of line of Railroad with calculations of Excavation and Embankment. Hencks's Field Book for Railroad Engineers. Searles's Field Engineering. *Civil Engineering*—Resistance of Materials. Bridges and Roofs, begun. Stone Cutting, with Graphical Problems. *Geology*—Dana's. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *French.*

SECOND TERM—*Civil Engineering*—Bridges and Roofs. Building Materials. Stability of Arches and Walls. Mahan's Civil Engineering. *Dynamics*—Principles of Mechanism. Steam Engine. *Hydraulics*—Hydraulics and Hydraulic Motors. *Drawing*—Graphical Statics. *Astronomy*—Loomis's Astronomy with practical problems. *Mineralogy*—continued. *Geology*—Dynamic. *French.*

(c.) IN DYNAMIC ENGINEERING:

JUNIOR YEAR:

FIRST TERM—*Mathematics*—Analytical Geometry of Three Dimensions; Elements of the Theory of Functions; Differential Calculus. *Surveying*—Field Practice. *Drawing*—Descriptive Geometry, begun. *German. French.*

SECOND TERM—*Mathematics*—Integral Calculus; Rational Mechanics. *Kinematics*—General Theory of Motion and Principles of Mechanism; Elementary Combinations of Pure Mechanism; Pulleys and Belts; Gearing and forms of teeth for Wheels; Parallel Motions. *Drawing* — Descriptive Geometry, concluded. *German. French.*

SENIOR YEAR:

FIRST TERM—*Statics*—Application of the Principles of Statics to Rigid Bodies; Elasticity and Strength of Materials; Forms of Uniform Strength; Stability of Structures; Construction of Roof Trusses, Girders, and Iron Bridges. *Machine Drawing*—Bolts and Nuts; Riveting; Journals, Axles, Shafts, Couplings, Pillow Blocks; Shaft-hangers, Pulleys; Connecting Rods and Cranks; Cross-heads; Pipe connections; Valves; Steam Cylinders, Stuffing Boxes, Glands, etc. Shop Visits. *Blowpipe Analysis. French.*

SECOND TERM—*Hydrostatics and Hydrodynamics*—Equilibrium and Pressure of fluids; Hydrometers, Manometers, Gauges, etc.; Water Pressure Engines and Water Wheels; Construction of Water Reservoirs and Conduits; Measurement of Water Supply; Discharge of pipes. *Thermodynamics*—General principles of Heat employed as a source of power; Theory of the Steam Engine; Hot Air Engines; Gas Engines. *Machine Designing*—Proportioning of Machine Parts, continued. Designing of Hoisting Engines; Shearing and Pumping Engines; Complete working-drawings for a high speed Steam Engine. Shop Visits and Reports. *Metallurgy.*

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(d.) IN AGRICULTURE:

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. *Qualitative Analysis*—Fresenius's. *Laboratory Practice. Blowpipe Analysis. German. French.*

SECOND TERM — *Theoretical Chemistry* — continued. *Laboratory Practice*—Quantitative Analysis. *Mineralogy*—Blowpipe Analysis and Determination of Species. *Physiology*—Huxley's. *Botany. French. German.*

SENIOR YEAR:

FIRST TERM—*Agriculture*—Cultivation of the Staple Crops of the Northern States. Tree Planting and Forestry. *Agricultural Chemistry* — Johnson's. *Organic Chemistry*—Lectures and Recitations. *Geology* — Dana's. *Botany. Zoölogy. English. French.*

SECOND TERM—*Agriculture*—Laws of Heredity and Principles of Breeding; Lectures. *Geology*—Dana's. *Rural Economy*—Systems of Husbandry. *Agricultural Chemistry*—Johnson's. *Organic Chemistry*—continued. *Geology*—Dana's. *Zoölogy. Botany. Microscopy. English. French.*

(e.) IN NATURAL HISTORY:

(Either Geology, Mineralogy, Zoölogy, or Botany, may be made the principal study, some attention in each case being directed to the other three branches of Natural History.)

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. *Qualitative Analysis*—Fresenius's; Laboratory Practice; Recitations. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *Botany*—Gray's Manual: Laboratory Practice. *German. French.*

SECOND TERM—*Zoölogy*—Laboratory Practice; Recitations; Excursions (land and marine). *Botany*—Laboratory Practice; Excursions. *Physiology*—Huxley's. *Mineralogy*—continued. *Physical Geography. German. French.*

SENIOR YEAR:

FIRST TERM—*Geology*—Dana's; Excursions. *Zoölogy*—Laboratory Practice; Lectures; Recitations; Excursions. *Botany*—Herbarium Studies; Gray's Textbook; Excursions. *French.*

SECOND TERM—*Geology*—Dana's. *Anatomy of Vertebrates*—Huxley's. *Zoölogy*—Laboratory Practice; Recitations; Lectures. *Botany* — Herbarium Studies, especially in the Cryptogamous Orders; Botanical Literature; Essays in Descriptive Botany. *Meteorology. French.*

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Besides the regular courses of recitations and lectures on structural and systematic Zoölogy and Botany, and on special subjects, students are taught to prepare, arrange, and identify collections, to make dissections, to pursue original investigations, and to describe genera and species in the language of science. For these purposes, large collections in Zoölogy and Palæontology belonging to the College are available, as are also the private botanical collections of Professor Eaton.

(f.) IN BIOLOGY PREPARATORY TO MEDICAL STUDIES:

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and recitations. *Qualitative Analysis*—Fresenius's; Laboratory Practice; Recitations. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *German. French.*

SECOND TERM—*Anatomy and Histology*—Laboratory Practice, Lectures and Recitations. *Physiology*—Huxley's; Practical Exercises. *Embryology*—Lectures. *Theoretical Chemistry*—continued. *Mineralogy*—continued. *Botany*—Lectures; Practical Exercises in Phenogamous Plants; Excursions. *German. French.*

SENIOR YEAR:

FIRST TERM—*Physiological Chemistry*—Recitations, Laboratory Practice, and Lectures. *Organic Chemistry*—Lectures and Recitations. *Zoölogy*—Lectures. *Botany*—Practical Exercises, Lectures and Excursions. *Geology*—Dana's. *French.*

SECOND TERM—*Physiological Chemistry*—continued. *Experimental Toxicology. Geology*—Dana's. *Zoölogy*—Lectures. *Sanitary Science*—Lectures. *Laws of Heredity and Principles of Breeding*—Lectures. *French.*

(g.) IN STUDIES PREPARATORY TO MINING AND METALLURGY:

Young men desiring to become Mining Engineers can pursue the regular Course in Civil or Mechanical Engineering, and at its close can spend a fourth year in the study of metallurgical chemistry, mineralogy, etc.

(h.) IN THE SELECT STUDIES PREPARATORY TO OTHER HIGHER STUDIES:

JUNIOR YEAR:

FIRST TERM—*Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *Physical Geography*—Guyot; Lectures. *English*—Early English. *History*—Bright's History of England. *French. German.*

SECOND TERM — *Mineralogy* — Lectures. *Astronomy. Botany* — Lectures; Excursions; Laboratory Practice. *English*—Chaucer, Bacon, Shakspere. *History*—Bright's History, continued. *German. French.*

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SENIOR YEAR:

FIRST TERM—*Geology*—Recitations and Excursions. *Zoölogy*—Lectures and Excursions. *Linguistics*—Whitney's Life and Growth of Language. *English*—Shakspere. *Constitutional Law of the United States*. *French*.

SECOND TERM—*Geology*—continued. *Meteorology*—Lectures. *Sanitary Science*—Lectures. *Political Economy*—Recitations and Lectures. *English*—Shakspere, Milton, Dryden, Pope, Gray, and later authors. *French*.

Exercises in English Composition are required during the entire course from all the students. The preparation of graduating theses is among the duties of the Senior Year.

Lectures on Military Science and Tactics are annually given by General Abbot, and other officers of the Engineer Corps of the United States Army.

DRAWING.—The course in drawing extends through the three years. During the first term of Freshman year, the students practice free-hand drawing at the Art School building, under the direction of Professor Niemeyer, of the Yale School of the Fine Arts. After the completion of the course in free-hand drawing, instruction is given by Mr. F. R. Honey, during the second term in the elementary principles of instrumental drawing, embracing Elementary projection drawing, Isometric drawing, and Descriptive Geometry as far as warped Surfaces. This course is obligatory upon all.

During the Junior and Senior years, instruction in drawing is obligatory only on the students in Civil and Mathematical Engineering. In the former year the system of instruction embraces shades and shadows, tinting, perspective, and warped surfaces. By this method all the problems in Descriptive Geometry are required to be worked out on the drawing-board instead of the black-board. The course extends through the entire year, and is under the direction of Mr. Honey.

In Senior year, students are required to apply the principles of drawing already obtained to works of construction, under the general supervision of the Professors of Civil and of Dynamic Engineering.

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VII.

METHODS OF INSTRUCTION.

The instruction in this institution is given chiefly in small class-rooms, in connection with recitations and by familiar lectures, illustrated by the apparatus at the command of the various teachers. In many studies weekly excursions are made for the purpose of collecting specimens and examining natural phenomena.

In Chemistry and Metallurgy the students work several hours daily in well-appointed laboratories, under the direct superintendence of the instructors, and are guided through systematic courses of quantitative and qualitative analysis, assaying, and the blow-pipe determination of minerals and ores.

In the course in Biology, instruction in Comparative Anatomy and Histology is given in the laboratory five or six mornings each week; the student working out for himself, by dissection and the examination of preparations, the anatomy of several types of animals, and making a large part of the microscopical preparations used in the study of the different tissues. In Physiological Chemistry the student works four hours daily in the study of the chemical processes of the body and in the preparation and examination of the more important proximate principles; thus, under the head of nutrition the various digestive processes are successively studied, artificial digestions are made, the products are separated and examined, while their physiological functions are demonstrated by experiments on animals. Special attention is also paid to the micro-chemistry of the various tissues. Students are likewise trained in qualitative and quantitative analysis of urine, both in health and disease, not alone for the practical results to be obtained, but especially for the means which it affords of studying the metabolic changes of the body. Toxicology is taught by experiments on animals; the absorption and elimination of poisons, together with other points of physiological value, being demonstrated by chemical analysis of tissues and secretions. In each of these subjects laboratory instruction is supplemented by recitations and lectures.

In Botany, during the summer of Junior year, exercises in analyzing and identifying plants occur two or three times a week, followed by practice in writing characters and descriptions of plants from living specimens. Students are shown also the best

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methods of collecting and preserving for future study, specimens of Flowering Plants, Ferns, Mosses, Algæ, etc. In the autumn term of Senior year the work of the summer is continued. Students are encouraged to pursue special lines of Botanical investigation, and varied assistance is rendered them according to their needs. The final examination is intended to show what they have learned, and the collections they have made are considered to be of minor importance.

In Zoölogy excursions are made during the Summer term of Junior and Fall term of Senior year, in company with the instructors, for the purpose of observing the habits and making collections of marine, fresh-water, and terrestrial animals of all classes. Each student is required to prepare and present for examination a collection containing a specified number of species, and illustrating the various classes of animals. He must also be able to pass an examination upon his collection, at least to the extent of explaining the classes and orders illustrated, and showing why particular specimens belong to the respective classes.

In Geology excursions are made for the purpose of examining geological phenomena and making special collections of rocks and minerals. Each student is required to pass a satisfactory examination on his collection at the end of the first term of Senior year.

In Civil Engineering the students, besides attending on Class recitations and lectures, pursue a systematic course of exercises in the different branches of Geometrical Drawing and Graphical Statics, and in the application of the principles of drawing to works of construction; and have good practice in the operations of Surveying and Field Engineering—acquiring facility in the use and adjustment of Surveying and Engineering Instruments. In Topographical Surveying they are instructed in the use of the Plane Table for topographical work, and are required to prepare a detailed chart of the ground surveyed—exhibiting the contour lines and all its topographical features. Numerous problems of computation, and graphical exercises, are included in the Course of Construction pursued in the Senior year. A course of Blowpipe Analysis is also taken by the Senior Class, that a more thorough knowledge may be gained of minerals and building stones.

In Dynamic Engineering the method of instruction is by recitation and lectures, supplemented by work in the drawing room, by shop visits, and visits of inspection in and out of the city, and

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by tests with the indicator and dynamometer. The lectures are illustrated by models, by large cartoons adapted for the purpose. and by the complete collection of working drawings of the Novelty Iron Works, owned by the School. In the drawing room, detailed working drawings of various machines are made. A general sketch of the proposed machine is given and complete detailed drawings are required, in proper shape for the pattern-maker or machinist. The student is taught the best practice, and his judgment is trained in choosing relative proportions. The student is required to describe the steps to be followed in building the machine, and to make as nearly as possible an estimate of its cost. Pattern, foundry, blacksmithing and machine work are studied in detail. In the visits, machinery and processes are critically examined in detail, and sketches of important machines with written descriptions are required.

In addition to the above, a course of lectures is given every winter by the professors of the schools and others, on topics of popular interest.

VIII.

TUITION CHARGES.

The charge for tuition for undergraduate students is $150 per year, payable, $55 at the beginning of the first and of the second term, and $40 at the middle of the second term. The student in the Chemical course has an additional charge of $70 per annum for chemicals and use of apparatus. He also supplies himself at his own expense with gas, flasks, crucibles, etc., the cost of which should not exceed $10 per term. A fee of $5 is charged members of the Freshman Class for chemicals and materials used in their laboratory practice, and the same fee is required from all (except Chemical students) who take the practical exercises in Blow-pipe Analysis and Determinative Mineralogy. A fee of $5 a term will also be charged to the students in the Zoölogical laboratory, for materials and use of instruments. An additional charge of $5 is annually made to each student for the use of the College Reading Room and Gymnasium.

For graduate students the charge for tuition is $100 per year.

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IX.

CHURCH SITTINGS.

Free sittings for students in this department of Yale College are provided as follows: in the Center Church (Congr.); in the Trinity (Episc.); and in the First Methodist Church.

Those who prefer to pay for a sitting for a year, more or less, in the churches above mentioned, or in any other church of any denomination, will be aided on application to the Secretary of the School.

Sittings in the Gallery of the College Chapel are free as heretofore to the students of this department.

X.

DEGREES.

Students of this department, on the recommendation of the Governing Board, are admitted by the Corporation of Yale College to the following degrees. They are thus conferred:

1. Bachelor of Philosophy: on those who complete any of the three-years courses of study, passing all the examinations in a satisfactory manner, and presenting a graduation thesis.

The fee for graduation as Bachelor of Philosophy, including the fee for Triennial Catalogues, Commencement Dinners, etc., is $10; unless the person taking the degree is also an academical graduate, when it is but $5.

2. Civil Engineer and Dynamical Engineer: The requirements for these degrees are stated on page 37.

3. Doctor of Philosophy: The requirements for this degree are stated on page 35.

XI.

TERMS AND VACATIONS.

The next academic year begins Thursday, September 24, 1885. The first term begins thirteen weeks from Commencement-day and continues thirteen weeks: the second term begins regularly on the first Thursday in January and continues until Commencement-day, with a spring recess—usually of eight days—including Easter. (See Calendar, p. 20.)

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XII.

ANNOUNCEMENT IN RESPECT TO STATE STUDENTS.

The scholarships established in this School in consequence of the bestowal upon it of the Congressional grants are designed to aid young men who are in need of pecuniary assistance in fitting themselves for agricultural and mechanical pursuits of life. All applicants must be citizens of Connecticut. In case there are more applicants than vacancies, candidates will be preferred who have lost a parent in the military or naval service of the United States, and next to these such as are most in need of pecuniary assistance; and the appointments will be distributed as far as practicable among the several counties in proportion to their population. The appointing Board for the current year, consisting of the Board of Visitors of the State and the Secretary of the School, will meet on June 23, 1885, and at or about the same time in the year 1886, due notice of which will be given by publication in every county in the State. All applications should be made previous to that time. Blank forms for application will be sent, when requested, by Professor GEORGE J. BRUSH, Secretary of the Appointing Board.

XIII.

ANNIVERSARY.

The Anniversary of the School is held on Tuesday of the Commencement week in Yale College, when selections from the graduation theses are publicly read. The degrees are publicly conferred by the President and Fellows of Yale College on Commencement Day.

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APPENDIX

ENTRANCE EXAMINATION PAPERS.

The following are the papers for 1884, upon which applicants for admission were examined at the June and September examinations.

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ARITHMETIC.

JUNE, 1884.

1. Reduce $\frac{3}{4}$, $\frac{5}{6}$, $\frac{4}{9}$, and $\frac{8}{11}$ to the least common denominator.

2. (*a*) Divide $\frac{\frac{7}{8}}{\frac{8}{11}}$ of $12\frac{1}{2}$ by $\frac{\frac{1}{8}}{7\frac{1}{2}}$ of $8\frac{3}{4}$.

(*b*.) Divide .0003538709 by .007643 and explain the position of the decimal point.

3. In 80937864 square inches how many acres?

4. A merchant sold a piece of cloth for $24, and thereby lost 25 per cent.; what would he have gained had he sold it for $34?

5. A gentleman wishes to take $1,000 from the bank; for what sum must he give his note, payable in 5 months, at 6 per cent. discount?

6. Extract the square root of 10 to five decimal places.

7. Give the approximate value of the meter in inches; of the gram in grains; of the kilogram in pounds avoirdupois.

8. What is to be the depth of a box 12^m long and 8^m wide, in order to hold 2,500 hectoliters?

ARITHMETIC.

SEPTEMBER, 1884.

1. Find the greatest common divisor of 918 and 522.

2. Reduce $\frac{7\frac{1}{2} \text{ of } 5\frac{6}{15}}{2\frac{11}{14} + 3\frac{7}{6}}$ to its lowest terms and express the result decimally.

3. I invested one-half of my capital in bank stock, and the balance in railroad stock. I gained 11 per cent. on the bank stock, and lost $7\frac{1}{2}$ per cent. on the railroad stock, and my net gain was $175. How much was my capital?

4. A and B engage in trade with $500. A put in his stock for 5 months, and B put in his for 4 months. A gained $10, and B gained $12; what sum did each put in?

5. Extract the cube root of 1860867.

6. When it is 2h. 36m. A. M. at the Cape of Good Hope, in longitude 18° 24′ east, what is the time at Cape Horn, in longitude 67° 21′ west?

7. Give the metric measures of length and their equivalents in denominations in use.

8. In a field 200 meters long and 56 meters broad, how many acres?

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GEOMETRY.

JUNE, 1884.

NOTE 1.—Candidates for examination in this subject as a whole should take the whole of this paper: those for the first year's partial examination, the first part of it: those for the second year's partial examination, the second part.

NOTE 2.—State at the head of your paper what text-book you have studied on the subject, and to what extent.

I.—*Plane Geometry.*

1. The bisectors of the three interior angles of a triangle meet in a point equally distant from the sides of the triangle.

2. The line drawn from the middle of one of the non-parallel sides of a trapezoid parallel to the parallel sides is equi-distant from them, equal in length to half their sum, and bisects the opposite side.

3. If from a point without a circle a secant and a tangent be drawn, the tangent is a mean proportional between the whole secant and the part without the circle.

4. (*a*) Define a geometric *locus*.

(*b*) If the base and vertical angle of a triangle be given; find the locus of the vertex.

5. If the apothegm of a regular hexagon is h, what is the area of the ring included between its inscribed and circumscribed circles?

II.—*Solid and Spherical Geometry.*

6. In a convex polyhedral angle the sum of the face angles is less than a circumference.

7. Similar polyhedrons are to each other as the cubes of their homologous edges.

8. The frustum of a cone of revolution whose altitude is 20 feet, and the diameters of its bases 12 feet and 8 feet respectively, is divided into two equal parts by a plane parallel to its bases. What is the altitude of each part?

9. Find the ratio of the surfaces, and the ratio of the volumes, of a cube and of the inscribed sphere.

10. In two polar triangles each side of the one is the supplement of the opposite angle of the other.

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GEOMETRY.

SEPTEMBER, 1884.

[State what text-book you have studied on the subject, and to what extent.]

1. Determine the symmetrical figure of a trapezium with respect to a point lying without, and with respect to an axis cutting the trapezium.

2. Of all triangles having the same base and equal perimeters, that which is isosceles is the maximum.

3. To construct a triangle which shall be equal in area to a given polygon.

4. Construct an angle of 60°, one of 30°, one of 120°, one of 45°, and one of 135°.

5. If a line intersect a plane, it makes a less angle with its projection than with any other line in the plane passing through the point of intersection.

6. The surface of a cone of revolution is 540 square inches; what is the surface of a similar cone whose volume is 8 times as great?

7. Define *equal spherical triangles* and *symmetrical spherical triangles*. Show that the latter cannot be made to coincide except in one case.

8. Find the surface and volume of a sphere whose radius is 10 inches; also find the area of a spherical triangle on this sphere, the angles of the triangle being 80°, 85°, and 100° respectively.

ALGEBRA.

JUNE, 1884.

NOTE 1.—Candidates for examination in this subject as a whole should take the whole of this paper: those for the first year's partial examination, the first part of it; those for the second year's partial examination, the second part.

NOTE 2.—State at the head of your paper what text-book you have studied on the subject and to what extent.

I.

1. Find the factors of $x^2 + 8x + 16$; $x^3 + 8$; $x^4 - 16$.

2. Solve the equation $\frac{ab+x}{b^2} - \frac{b^2-x}{a^2b} = \frac{x-b}{a^2} - \frac{ab-x}{b^2}$.

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3. Given $\frac{a}{x}+\frac{b}{y}=m$ and $\frac{b}{x}-\frac{a}{y}=n$, to find x and y.

4. (*a*) Expand $(x+2)^4$. (*b*) Simplify $\sqrt[3]{a^3+3a^2b+3ab^2}+b^3$.

5. Simplify (*a*) $\sqrt[4]{16a^{12}b^8c^4}$. (*b*). $\sqrt[6]{\frac{64x^{18}}{729x^6}}$.

(*c*). $(-1)^{2n}$. (*d*). $\sqrt[3]{81}-\sqrt[3]{192}$.

II.

6. Solve the equation $8x^2-7x+34=0$ and verify your solution.

7. Given $x-y=7$ and $x^2+xy+y^2=13$, to find x and y.

8. Given $\frac{\sqrt{7x^2+4}+2\sqrt{3x-1}}{\sqrt{7x^2+4}-2\sqrt{3x-1}}=7$, to find x.

9. Insert two geometrical means between a and b.

10. What sum of money (s) must be set apart annually, and put at compound interest as a sinking fund, to pay a debt of a dollars in n years, if the interest on one dollar for one year is r?

ALGEBRA.

September, 1884.

[State what text-book you have studied on the subject and to what extent.]

1. Given $\frac{x-y+1}{x-y-1}=a$, and $\frac{x+y+1}{x+y-1}=b$, to find x and y.

2. If $\frac{a_1}{b_1}=\frac{a_2}{b_2}=\frac{a_3}{b_3}=r$, show (1) that $r=\frac{a_1+a_2+a_3}{b_1+b_2+b_3}$.

(2) that $r=\sqrt[2]{\frac{a_1^2+a_2^2+a^2}{b_1^2+b_2^2+b^2_3}}$.

3. Expand $(x-2a)^5$ by the binomial formula.

4. Simplify (1.) $\frac{x^{\frac{3}{2}}-y^{\frac{3}{2}}}{x^{\frac{1}{2}}-y^{\frac{1}{2}}}$. (2.) $\sqrt{8}+\sqrt{50}-\sqrt{18}$.

(3.) $\sqrt[3]{2}\times\sqrt[3]{\frac{1}{3}}\times\sqrt[3]{3}$. (4.) $(\sqrt{-1})^5$.

5. Find the square root of $28+10\sqrt{3}$, in its simplest form.

6. Form an equation whose roots shall be 3 and -5.

7. Solve the equation $6x^2+x-12=0$ and resolve its first member into its factors.

8. The number of permutations of n things 3 together is 6 times the number of combinations 4 together, find n.

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9. Develop $\frac{1+x}{2+3x}$ into a series by the method of indeterminate coefficients (four terms of the series will suffice).

10. (1) What is the logarithm of zero in a system whose base is greater than one? Demonstrate your answer.

(2.) Transform $\log \sqrt[2]{\frac{a^3b^4c^5}{de}}$ into a form well adapted to computation.

TRIGONOMETRY.

JUNE, 1884.

[State what text-book you have studied on the subject, and to what extent.]

1. Define the *radian* or unit of circular measure of an angle. Express an angle of 0.5 in degrees.

2. Deduce a formula for expressing $\sin \alpha$ in terms of $\tan \alpha$.

3. Assuming the fundamental formula for the cosine of the sum of two angles show that

$$\cos \tfrac{1}{2}\alpha = \sqrt{\frac{1 + \cos \alpha}{2}}.$$

4. Given (*a*) $\tan x + \cot x = 10$ to find $\tan x$.

(*b*) $\sec x + \tan x = \frac{4}{3}$ to find $\tan x$.

How many values of x are there between 0 and 2π that will satisfy these equations respectively?

5. Write the usual formulæ for solving the different cases of oblique plane triangles, and explain carefully your notation.

6. Having given three sides of a triangle $a = 701.22$ feet, $b = 438.26$ feet, $c = 613.57$ feet to find the three angles and the area of the triangle. Check your calculation of the angles, and show how you might check that of the area.

TRIGONOMETRY.

SEPTEMBER, 1884.

[State what text-book you have studied on the subject, and to what extent.]

1. Express 60° in *radians* or units of circular measure.

2. Find the functions of 930°.

3. Name the angles between 0° and 720° whose tangent is 1; also those whose tangent is -1.

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4. Assuming the usual data deduce the following formulæ.

(1) $\tan 2a = \frac{2 \tan a}{1 - \tan^2 a}$.

(2) $\sin a + \sin b = 2 \sin \frac{1}{2}(a + b) \cos \frac{1}{2}(a - b)$.

5. Given $\tan\left(\frac{\pi}{4} - \theta\right) + \cos\left(\frac{\pi}{4} - \theta\right) = 4$, to find $\tan \theta$.

6. Given two sides of a triangle, $b = 2956.2$, $c = 9090.6$ and the included angle $A = 98° 29'.6$ to find the remaining parts of the triangle.

ENGLISH GRAMMAR.

JUNE, 1884.

[State what text-book you have used.]

I. Define noun, pronoun, interjection and conjunction.

II. Inflect throughout the personal pronouns.

III. State the difference between the strong (or old) and the weak (or new) conjugation of the verb, and give three illustrative examples of each.

IV. Parse the following sentence.

The best men whom he had seen were opposed to the views that he advocated.

LATIN.

JUNE, 1884.

I. Translate *as literally as possible:*

a. Quod si veteris *contumeliae* oblivisci vellet, num etiam recentium *injuriarum*, quod, eo invito, iter per provinciam per vim tentassent, quod Aeduos, quod Ambarros, quod Allobrogas vexassent, memoriam deponere posse? Quod sua victoria tam insolenter gloriarentur, quodque tam diu se impune injurias tulisse admirarentur, eodem pertinere.

b. Hanc si nostri transirent, hostes exspectabant; nostri autem, si ab illis initium *transeundi* fieret, ut impeditos aggrederentur, parati in armis erant. Interim proelio equestri inter duas acies contendebatur. Ubi neutri transeundi initium faciunt, secundiore equitum *proelio* nostris, Cassar suos in castra reduxit.

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c. Nostri primo integris viribus fortiter *repugnare*, neque ullum frustra telum ex loco superiore mittere; ut quaeque pars castrorum *nudata* defensoribus premi videbatur, eo occurrere et auxilium ferre, sed hoc superari, quod diuturnitate pugnae hostes defessi proelio excedebant, alii integris viribus succedebant.

d. At hostes ubi primum nostros equites conspexerunt, quorum erat quinque millium numerus, quum ipsi non amplius octingentos equites haberent, quod ii, qui *frumentandi* causa ierant trans Mosam, nondum redierant, nihil timentibus nostris, quod legati eorum paulo ante a Caesare discesserant atque is dies *induciis* erat ab his petitus, impetu facto celeriter nostros perturbaverunt.

e. Mittuntur ad Caesarem confestim ab Cicerone litterae, magnis propositis praemiis si *pertulissent.* Obsessis omnibus viis missi intercipiuntur. Noctu ex materia, quam munitionis causa comportaverant, turres admodum centum et viginti excitantur incredibili celeritate: quae deesse *operi* videbantur, perficiuntur.

f. Ubii, qui ante obsides dederant atque in deditionem venerant, purgandi *sui* causa ad eum legatos mittunt, qui doceant neque auxilia ex sua civitate in Treviros missa, neque ab se fidem laesam: petunt atque orant, ut sibi parcat, ne communi *odio* Germanorum innocentes pro nocentibus poenas pendant, si amplius *obsidum* velit, dare pollicentur.

II.—1. Decline *iter* (2), *veteris* (1), *vim* (3).

2. Compare *secundiore* (11), *fortiter* (13), *primo* (13).

3. Write the synopsis, active and passive, of *conspexerunt* (19).

4. Parse in full each word in the first two lines of passage *c.*

5. Give the principal parts of the following: *oblivisci* (1), *vellet* (1), *deponere* (4), *premi* (15), *excedebant* (17), *petitus* (24), *obsessis* (27), *deesse* (30), *perficiuntur* (31), *doceant* (34), *laesam* (35), *parcat* (35), *pendant* (37).

6. State the construction of all italicized words.

7. Quote (in full) from the above text an example of indirect statement.

8. Convert into direct statement the example quoted in answer to question seventh.

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LATIN.

SEPTEMBER, 1884.

I. Translate as literally as possible—

a. Ubi per exploratores Caesar certior factus est, tres jam copiarum partes Helvetios id *flumen* transduxisse, quartum vero partem citra flumen Ararim *reliquam* esse, de tertia vigilia cum legionibus tribus e castris profectus ad eam partem pervenit, quae nondum flumen transierat.

b. Interim omnis ex fuga Suessionum multitudo in oppidum proxima *nocte* convenit. Celeriter vineis ad oppidum actis, aggere jacto, turribusque constitutis, magnitudine operum, quae neque viderant ante Galli neque audierant, et celeritate Romanorum *permoti*, legatos ad Caesarem de deditione mittunt, petentibus Remis ut conservarentur impetrant.

c. Itaque quum intelligeret omnes fere Gallos novis *rebus* studere et ad bellum mobiliter celeriterque excitari, omnes autem homines natura libertati studere et conditionem servitutis odisse, priusquam plures civitates conspirarent, partiendum *sibi* ac latius distribuendum exercitum putavit.

d. Quod ubi Caesar animadvertit, naves longas, quarum et species erat *barbaris* inusitatior et *motus* ad usum expeditior, paulum removeri ab onerariis navibus et remis incitari et ad latus apertum hostium constitui, atque inde fundis, sagittis, tormentis, hostes propelli ac submoveri jussit: quae res magno usui *nostris* fuit.

e. Ex his omnibus longe sunt humanissimi, qui Cantium incoluut, quae regio est maritima omnis, neque multum a Gallica differunt *consuetudine.* Interiores plerique frumenta non serunt, sed lacte et *carne* vivunt pellibusque sunt vestiti.

f. Erat, ut supra demonstravimus, manus certa nulla, non oppidum, non praesidium, quod se *armis* defenderet, sed omnes in partes dispersa *multitudo.* Ubi cuique aut vallis abdita aut locus silvestris aut palus impedita spem praesidii aut salutis aliquam offerebat, consederat.

II.—1. Decline *certior* (1), *aggere* (8), *turribus* (8).

2. Compare *mobiliter* (13), *latius* (16), *apertum* (20).

3. Write the synopsis, active and passive, of *propelli* (21), or *removeri* (19).

4. Parse in full each word in the last two lines of passage *c.*

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5. Give the principal parts of the following: *profectus* (4), *jacto* (8), *mittunt* (11), *studere* (13), *odisse* (15), *animadvertit* (17), *incolunt* (24), *differunt* (25), *vivunt* (26), *serunt* (26), *dispersa* (29), *consederat* (31).

6. State the construction of all italicized words.

7. Quote (in full) from the above text an example of indirect statement.

8. Convert into direct statement the example quoted in answer to question seventh.

LATIN EXERCISE.

JUNE, 1884.

1. Despatches[1] are immediately[2] sent[3] by Cicero[4] to[5] Caesar.

2. Cicero immediately sends despatches to Caesar.

3. The despatches were not carried-through[6], as all the roads were occupied. (Use the ablative absolute.)

4. The messengers[7] are captured[8] *in consequence of the occupation of the woods* (ablative absolute).

5. If the roads had not been occupied the messengers would not have been captured (ablative absolute).

6. Since the enemy had occupied the roads, the messengers were unable to carry-through the despatches.

7. The messengers say they will carry through the despatches.

8. Rewrite sentence seventh so as to illustrate direct statement.

9. The messengers formed the plan of *carrying through the despatches.* (Translate the italicized words in two ways.)

10. The messengers, who *through the occupation of the woods* (abl. absolute), were unable to carry through the despatches were captured by the enemy (plural).

[1] litterae. [2] confestim. [3] mittere. [4] Cicero. [5] ad. [6] perferre. [7] missus. [8] intercipere.

LATIN EXERCISE.

SEPTEMBER, 1884.

1. The Helvetians[1] lead[2] (their) forces across[3] the river[4].

2. The forces of the Helvetians are being led across the river.

3. Caesar was informed[4] (that) the Helvetians were leading their forces across the river.

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4. Caesar was informed (that) the Helvetians had led their forces across the river.

5. Three-fourths (i. e. parts[5]) of the forces were led across the river by the Helvetians.

6. Three-fourths of the forces having been led across the river; Caesar cut to pieces[6] the fourth[7] part.

7. The fourth part which had not yet[8] crossed[2] the river was cut to pieces by Caesar.

8. Caesar departs[9] with three legions[10] *to cut to pieces a part of the Helvetians.* (Translate the italicized words in two ways.)

9. Caesar says he has cut to pieces the fourth part of the forces.

10. Caesar said he had cut to pieces the fourth part of the forces.

[1] Helvetius. [2] transducere. [3] flumen. [4] certior fieri. [5] pars. [6] concidere. [7] quartus. [8] nondum. [9] proficisci. [10] legio.

GEOGRAPHY.

June, 1884.

1. Bound the State of Pennsylvania; state the names of its chief cities and tell how they are situated; what are the principal rivers in the State and on its borders?

2. Where does the Missouri River rise; describe the direction of its course; what States and territories does it pass through or touch from its head to its mouth?

3. Name the States and countries in their order, which touch the Gulf of Mexico, beginning on its northeast.

4. Bound Brazil; give the names of two cities in it and tell how they are situated; what are its chief rivers and in what part of the country do they run?

5. Bound China; give the names of three of its cities and tell how they are situated; tell what are its chief rivers and where they run.

6. Where are the following islands: Azores; Bermudas; Phillipine; Disco; St. Helena?

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GEOGRAPHY.

SEPTEMBER, 1884.

1. Bound the State of Kentucky; give the names of its chief cities, and tell how they are situated; what are the principal rivers in the State and on its borders?

2. Where is the river Danube; where does it rise, what direction does it run, where does it empty and what countries does it touch in its course?

3. What countries surround the Baltic Sea; tell which direction each lies from the sea; where and what is the entrance to the sea.

4. Beginning east, name in their order the States and territories of the United States which touch Mexico; name one city in each of these States and territories.

5. Bound Siberia; to what government does it belong; what mountains on its western boundary; name two rivers in it which empty into the Arctic ocean; what peninsula in its eastern part?

6. Where are the following cities: Havana; Florence; Winnipeg; Atlanta; Acapulco?

HISTORY OF THE UNITED STATES.

JUNE, 1884.

I. Give the dates of the battle of Great Meadows, the Hartford convention, the emancipation of the slaves, Missouri Compromise and state who was President in 1820, 1830, 1840, 1850.

II. Give an account of the formation of the colony of Maryland.

III. How and by what nation was Manhattan Island first settled, and how did it come into the possession of England?

IV. Describe the Stamp Act. When was it passed and when and why repealed?

V. Relate the causes of the War of 1812 and state by what treaty it was ended.

VI. What was the Kansas-Nebraska bill and when was it passed?

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HISTORY OF THE UNITED STATES.

SEPTEMBER, 1884.

I. Give the dates of the Albany convention, the battle of Tippecanoe, Dorr's Rebellion, the attack on Fort Sumter and state who was president in 1812, 1822, 1832, 1842.

II. Describe the planting of the colony of Pennsylvania.

III. Give an account of the Pequod War.

IV. When and why was the Boston Port Bill passed and what did it provide?

V. Give an account of Shays' Rebellion.

VI. What treaty ended the Mexican War and what were its provisions?

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The Annual Report will be sent regularly to all graduates who may express the desire to receive it, and who furnish their addresses for the purpose. It is desirable that any change of address should be communicated by the first of January of each year.

For Circulars and other information, address

PROFESSOR G. J. BRUSH,

NEW HAVEN, CONN.

TWENTIETH ANNUAL REPORT

OF THE

SHEFFIELD SCIENTIFIC SCHOOL

OF

YALE COLLEGE,

1885-86.

PRINTED BY ORDER OF THE GENERAL ASSEMBLY.

NEW HAVEN:
TUTTLE, MOREHOUSE & TAYLOR, PRINTERS.
1886.

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STATE BOARD OF VISITORS.

CONSTITUTING, WITH THE SECRETARY OF THE SCHOOL, THE BOARD FOR THE APPOINTMENT OF STATE STUDENTS.

Governor.

HIS EXCELLENCY HENRY B. HARRISON, New Haven.

Lieutenant-Governor.

HIS HONOR LORRIN A. COOKE, Barkhamsted.

State Senators.

HON. JOSEPH W. ALSOP, Middletown.

__ _____ _____ _____

__ _____ _____ _____

Secretary of State Board of Education.

CHARLES D. HINE.

Secretary and Treasurer of the School.

GEORGE J. BRUSH.

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REPORT

OF THE

STATE BOARD OF VISITORS.

To the General Assembly of the State of Connecticut:

The Board of Visitors have the honor to transmit herewith the Annual Statement of the Governing Board of the Sheffield Scientific School.

The Agricultural College Fund amounts to $135,000. Of this amount, $128,925 is invested in bonds and mortgages bearing interest at the rate of not less than five per cent. per annum, the minimum prescribed by the Act of Congress creating the fund. There is in the hands of the Treasurer of the State $6,075 on which the State pays interest at the rate above mentioned. The interest actually received from invested funds for the year ending December 31st, 1885, was $6,386.24.

The sum thus received and paid to the School is wholly devoted to scholarships, which are distributed among the counties of the State in proportion to their population. Thus to a considerable body of promising young men the State extends ample and thorough instruction in "Agriculture and the Mechanic Arts." The number of applicants largely exceeds the number of scholarships which the fund can provide.

To the State as thus connected with the School, great and essential and constantly increasing benefits accrue. The

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interest received constitutes about one-eighth of the amount expended by the officers of the School. To every dollar given are added seven,—immeasurably increasing the utility and power of the sum contributed. Moreover, here original research is instituted and carried to its practical applications. In the broadest and best sense, scientific training is furnished and at the same time the basis of technical skill is laid. In sight of our busy communities and in active sympathy and coöperation with them is a prosperous training school for mechanics, manufacturers and farmers. It follows that those who have held scholarships have been the recipients of thorough and stimulating instruction, to the infinite advantage of the commonwealth. It is known that most of these beneficiaries are now engaged in mechanical occupations or farming in this State, and are giving intelligent impulse and direction to our industrial energies.

The State could well afford to extend such education, to all who desire to obtain it.

HENRY B. HARRISON,
Chairman.

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ANNUAL STATEMENT

OF THE

GOVERNING BOARD.

In presenting their twentieth Annual Statement, the Governing Board of the Sheffield Scientific School have again the gratification of reporting the continued prosperity of the institution, so far as that is indicated by the increase of attendance. The whole number of students on their rolls is slightly larger than ever before. More than that, the entering class of this year is the largest that has ever been admitted. It is satisfactory to feel that the work done by the School is appreciated especially in this State, from which the number of students regularly increases from year to year. At the same time it is easy to overrate the importance of this fact. The excellence of an institution can never be tested by the numbers in attendance, nor can the growth in that direction of any scientific school long compensate for any failure on its part to keep up with the demand for full instruction in the various departments allied to the practical concerns of life. As therefore of special importance in connection with the manufacturing interests of this State, the Governing Board call attention both to what has been done during the past year and what still needs to be done in the departments of Physics and of Dynamical or

Mechanical Engineering.

The small Bigelow steam engine, a gift acknowledged in a previous report, has been set at work in the basement of North Sheffield Hall in connection with a dynamo-electric machine belong-

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ing to the department of Physics. The engine is supplied with steam from a new boiler, bought last year on liberal terms of Messrs. H. B. Bigelow & Co.

It is intended that this apparatus shall be used for experimental purposes, to afford graduate students opportunity to conduct original investigations, and that the room in which the engine is placed shall form the nucleus of an Engineering Laboratory, the equipment of which can be improved and increased as rapidly as the means of the School or liberality of donors to this object will permit. It would be of great advantage to the department of engineering, and would increase the good reputation of the School to have a thoroughly well equipped Engineering Laboratory in which investigations which would add to the stock of useful knowledge in this province of science could be carried on to advantage. The increased facilities thus offered would induce students to take the graduate course and would attract special students.

Among the gifts to this department, not before reported, are the following:

A gauge for measuring the draught force of chimneys—from the Hartford Steam Boiler Inspection and Insurance Co.

A 2-inch swivel vise with swivel jaw—from the Bagley & Sewall Co., Watertown, N. Y.

An old McNaught steam engine indicator, in excellent condition—from the Colt's Pat. Fire Arms Mfg. Co., Hartford.

A model of an ingenious friction clutch pulley—from the inventor, Mr. Albert B. Bean, New Haven.

A No. 1 Gaskell steam pump, highly finished and nickel plated, with portions cut away to exhibit the interior—from the Holly Manufg. Co., Lockport, N. Y.

A set of standard end measure gauges, one inch, one-half inch, and one centimeter long—from the Pratt & Whitney Co., Hartford. These standards are of extreme accuracy and are very valuable.

The same firm have also, during the past year, given to the department complete sets of blue prints of the details of machinery they are engaged in making. There are about 40 sheets of these working drawings mounted on heavy pasteboard and varnished, and they form an important addition to the collection of working drawings which are used in giving instruction in machine designing. Contributions of the kind enumerated above are urgently

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solicited from the graduates of the School who are now in the practice of their profession, and from manufacturers of machinery and mechanical appliances. The models and drawings are always open to the examination of the students and are studied by a large number of young men who are being educated to fill positions as mechanical engineers.

The opportunity must be taken here to acknowledge the kindness of the officers and contractors of the New Haven Manufacturing Co. in permitting the students of Mechanical Engineering to visit their shops daily. They have afforded every facility to the student for studying the operations in shop practice, and for examining and sketching the details of finished machinery and machines in process of construction.

The New York, New Haven and Hartford R. R. Co. have also kindly given permission to the students to visit frequently the extensive construction and repair shops of the Road. These opportunities are taken advantage of to give the students familiarity with a variety of machinery of excellent quality.

A course of lectures on the theory of electricity and its applications will be open to students in the department of Engineering, and these lectures can be taken as a part of the preparation for a graduate course in the higher branches of electrical science.

Attention is called to a want which is much felt in this department. The valuable unbound engineering periodicals which are now very numerous and are accumulating rapidly in the library, are necessarily accessible only with difficulty in their present condition, but could be made available for frequent reference if bound. A fund is much needed to meet the expense of binding these periodicals, for they contain records of the most recent developments in the sciences to which they relate, and a familiarity with their contents is important to the instructors and the students.

Department of Physics.

The principal addition to the apparatus during the past year is the dynamo-electrical machine from Dr. Edelmann's shops in Munich. It is driven by a four horse-power engine, presented by Mr. Frank Bigelow to the department of Dynamical Engineering, and is contained with the engine in one of the rooms belonging to that department. The machine is admirably constructed, and of quite sufficient capacity to meet all our wants. Arrangements for

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virtually altering the winding of the machine not only renders it peculiarly convenient for a wide range of uses but also adapt it for experimental study. The limits of its power are eleven Ampères with an electro-motive force of eighty volts and twenty-two Ampères with forty volts. Higher values than these, although quite attainable with the liberal engine-power at our command, are attended with dangerous heating of the machine if long continued.

The dynamo is connected by well insulated and very thick copper conductors in the lecture room of the department, as also with the large lecture room. In the engine room, properly connected with the circuit, are a voltmeter and an am-meter of the Charpentier form. An electric bell in an independent circuit from the lecture room admits of easy communication with the attendant in the engine room.

Other additions to the apparatus are as follows:

A tangent galvanometer with coarse and fine windings. This was made by rewinding a galvanometer from a German workshop so as to render the computation of its contents possible, and also changing the needle to one of less than a tenth of the mass of that provided by the maker. The pointers, of fine aluminium wire, now move over a mirror bottom of the compass-box.

A heliostat having two mirrors, of which one only moves by clock-work; it directs a beam of light never less than four inches in diameter whatever the position of the sun above the horizon.

A clock with a compensating seconds pendulum provided with a novel arrangement for closing an electric circuit at every swing so that the energy taken from the clock is extremely minute, while at the same time the contact is perfectly satisfactory even with very large currents. As is well known to those who have attempted to use mercury contacts for intense currents the performance is unusual.

A comparator with microscopes, which admits, however, of comparing lengths to a moderate degree of accuracy only.

A meter-scale of bronze for use as a secondary standard of length.

An Attwood's machine. This, instead of having an independent pendulum and clock-work, is introduced at will into the circuit of the standard clock which liberates the weights and sounds the successive seconds.

An apparatus for studying color sensations by Maxwell's method, with a large number of discs.

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The only changes during the year in the undergraduate department are those accompanying a change in text-books used, Stewart's Physics being found wholly inadequate to the needs of the class. Everett's Deschanel has been adopted for the present year. After the first of January, 1886, however, an optional course in electricity, adapted to seniors or graduates who have pursued mathematical courses, is to commence and extend through the year. It will consist primarily of two lectures a week interrupted occasionally by examinations on the work gone over. In addition to this a small number will have an opportunity for practical work in the physical laboratory. Whatever may be the demand for opportunities of this kind the facilities for satisfying them are narrowly restricted by insufficient room. It is impossible for the School, with the facilities at present at its command, to accommodate students who seek to pursue higher courses of study in a subject which is now attracting the attention of constantly increasing numbers: and it is a matter of first importance to the prosperity of the School that its deficiencies in these respects should be remedied as early as possible.

Necessity of Increased Endowments.

The statements in regard to the courses in Physics and Mechanical Engineering points very clearly to the necessity of more liberal endowments, if the School is to maintain the position it has so honorably won and hitherto firmly held. The studies are optional with certain limitations. This is in accordance with the tendency of the best modern educational methods; and indeed upon the maintenance of it the success of the institution depends. But optional courses are necessarily very expensive. They involve the procuring of a large number of instructors, some of whom must be and all of whom ought to be specialists. They involve also the constant supply of educational apparatus to carry on the higher work which is demanded by and for the better students. The resources of the institution have been steadily taxed to the utmost to meet both of these demands: and the Governing Board have constantly to undergo the mortification of being compelled to refuse students the privilege of pursuing certain branches of study, because they have not the means at their command to pay additional and competent instructors or to equip those on hand with the proper facilities for carrying on their work. Yet

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they feel confident that everything which can be done with their present limited resources is done. The income from all sources of the School is about sixty thousand dollars a year. Of this, about fifty-five thousand is applied to the payment of instructors, leaving the scant sum of about five thousand dollars for all the other expenses, such as lights, fuel, insurance, care of buildings, repairs, payment of janitors, and other details connected with administration. It ought likewise to be added that the pay of the professors is lower in this department than in any of the endowed departments of the University; and that many of them have refused positions in other institutions, and in some instances in other callings in life, which would have yielded salaries far higher than they receive here. It can hardly be expected, however, nor is it right to expect, that men will forever continue to sacrifice their own personal prospects for the sake of a public institution, no matter how profoundly they may be interested in its success, and the graduates and friends of the School should see that they are placed under no such necessity.

Zoological Collections.

A. E. Verrill, Curator; K. J. Bush and C. E. Bush, Assistants.

The most important additions to the collections, as during several years past, have been due to the coöperation of the curator with the U. S. Fish Commission in the exploration of the deep sea off our coast. During the past season the dredgings were carried on in the region of the Gulf Stream, from off Georgia to Newfoundland, and from shallow water to 2620 fathoms, by means of the steamer Albatross, Lieut. Z. L. Tanner commanding. The Grand Bank of Newfoundland was also extensively explored. The party was organized nearly as in 1883. Very large collections were made, and the larger part of the Invertebrata were sent here for identification and description, as in previous years.

The curator has published during the year in the American Journal of Science, and in the Annual Report of the Fish Commission accounts of these and previous explorations. He has also published the third descriptive catalogue of the deep-sea Mollusca, illustrated by several plates, in the Transactions of the Connecticut Academy, vol. vi. In these papers numerous species are added to the fauna, a large part of them new.

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Professor S. I. Smith has taken charge of the Crustacea, and has published in the Proceedings of the National Museum, two papers on the new Decapod Crustacea dredged by the Albatross, mostly in 1884, and one on the Penæidæ. He has also prepared for the Annual Report of the U. S. Fish Commission, a detailed report on the Decapod Crustacea of 1884, with numerous plates.

Mr. J. H. Emerton has published a paper on the New England spiders of the family Lycosidæ in the Transactions of the Connecticut Academy, with four plates.

Miss K. J. Bush has continued the work of cataloguing and labeling the collections of shells, etc., dredged by the Fish Commission. She has also published in the Transactions of the Connecticut Academy, vol. vi, a descriptive Catalogue of the shallow water shells, new to the region, dredged by the Albatross near Cape Hatteras in 1883 and 1884. This includes a considerable number of new species and is illustrated by a plate.

Miss C. E. Bush has also been employed as an assistant on the collections of Invertebrates in the museum.

Numerous private collections that have been deposited in the museum by the curator during the past twenty years, have recently been purchased by the trustees of the museum. Among these are the large and fine series of shells, corals and echinoderms, from the Gulf of California, including the original types of numerous new species formerly described by the curator; valuable collections of corals from the East Indies and Pacific Ocean; large series of the marine invertebrates of New England, collected prior to 1873; a collection of New England birds and mammals, etc.

In addition to the collections dredged by the U. S. Fish Commission the following have been received:

J. K. Payne, Knoxville, Tenn. Collection of Unionidæ.

J. F. Whiteaves, Ottawa, Canada. Marine invertebrates from northern Labrador.

H. G. Fitz, New York. Several good, large, fresh examples of the southern *Mellita testudinata*, and rare shells from Long Island Sound, near Huntington, L. I.

Prof. J. S. Newberry. Sponge (*Verongia*) from Florida.

Dr. W. O. Ayres. Shells from the basin of Lake Lahontan.

B. H. Wright, De Land, Florida. Fresh-water Phyllopod Crustacea, in alcohol.

Dr. George Bauer, Peabody Museum. Two salamanders from Europe.

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R. Ellsworth Call, Moline, Ill. Collection of Unionidæ from the Mississippi River; collection of Unionidæ and fresh water univalves from Tennessee and Alabama. By purchase.

Geo. E. Verrill, S. S. S., 1885. Birds' skins and eggs from Grand Manan, N. B.; mounted birds from New Haven.

Mrs. R. W. Summers, San Luis Obispo, Cal. Echinoderms and barnacles.

J. B. Hatcher, S. S. S. 1884. Lizard from Phillips Co., Kansas.

A. Herman. Bald eagle from Orange. Purchased.

A. E. Verrill. Albino flying squirrel from New Haven.

Mr. Gardiner. Fish (*Merlucius albidus*), from Short Beach.

A. E. Verrill. Land Shells from New Haven.

C. Hartt Merriam, M.D. Invertebrates from Labrador.

States Represented in the School.

The following table shows the States and Countries from which come the students whose names appear on the catalogue during the current year, and the proportion of numbers that belong to each.

	Graduates.	Seniors.	Juniors.	Freshmen.	Special.	Total.
1. California	--	3	--	3	1	7
2. Colorado	1	2	1	3	--	7
3. Connecticut	14	23	24	38	4	103
4. District of Columbia	1	1	--	1	1	4
5. Georgia	--	1	--	--	--	1
6. Illinois	--	5	6	9	--	20
7. Indiana	--	--	3	--	--	3
8. Kentucky	--	1	--	1	--	2
9. Louisiana	--	--	--	1	--	1
10. Massachusetts	--	--	2	1	--	3
11. Michigan	--	1	1	1	--	3
12. Minnesota	--	4	1	--	--	5
13. Missouri	--	2	--	--	--	2
14. Nebraska	--	2	1	1	--	4
15. New Jersey	1	2	1	--	1	5
16. New York	5	8	14	17	--	44
17. Ohio	--	3	4	5	1	13
18. Pennsylvania	--	4	6	4	--	14
19. Rhode Island	--	1	--	4	--	5
20. Texas	--	1	1	--	--	2
21. Virginia	1	--	--	1	--	2
22. Wisconsin	--	--	--	--	1	1
23. China	1	--	--	--	--	1
24. Japan	--	--	--	1	--	1
25. Sandwich Islands	--	--	--	2	--	2
26. Saxony, Germany	--	--	1	--	--	1
Total	24	64	66	93	9	256

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To a certain extent these statistics are deceptive. Connecticut has always a number added to what belongs to it legitimately, from the fact that families come here from other States and take up a temporary residence for the sake of educating their children. Graduate students also frequently change their residences to New Haven.

Public Lectures.

The annual course of lectures to mechanics and others was given during the second term of the Academic year, 1884-85. The lectures and their subjects are indicated in the annexed programme:

I.	Thursday, Feb.	12.—Norway and the Midnight Sun.	Rev. Dr. C. C. Tiffany.
II.	Tuesday, "	17.—Science and the Supernatural.	Prof. Du Bois.
III.	Thursday, "	19.—The Present Commercial Crisis.	Mr. A. T. Hadley.
IV.	Tuesday, "	24.—The Asiatic Cholera.	Prof. Brewer.
V.	Thursday, "	26.—The Sensation of Color.	Prof. Hastings.
VI.	Tuesday, Mar.	3.—Cobwebs.	Mr. J. H. Emerton.
VII.	Thursday, "	5.—Lafayette.	Prof. A. M. Wheeler.
VIII.	Tuesday, "	10.—The Patent Law of the U. S.	Prof. Robinson.
IX.	Thursday, "	12.—Commemoration of the Birthday of Bishop Berkeley.	President Porter.
X.	Tuesday, "	17.—The Surface Life of the Gulf Stream.	Prof. Verrill.
XI.	Thursday, "	19.—Map Projection.	Prof. Phillips.
XII.	Tuesday, "	24.—Apples.	Prof. Daniel C. Eaton.

Lectures on Military Science.

A course of Lectures on Military Science, by officers of the U. S. Engineering School at Willets Point, was delivered in North Sheffield Hall as a part of the instruction in the School during the second term of the academic year 1884–85.

The order and subjects of the Lectures were as follows:

I.	Friday, Feb. 27.	—Strategy and Grand Tactics.	1st Lieut. Eugene J. Spencer, U. S. Engineers.
II.	Monday, Mar. 2.	—Logistics.	1st Lieut. James L. Lusk, U. S. Engineers.
III.	Friday, "	6.—Small Arms and their influence on Tactics.	1st Lieut. Harry F. Hodges, U. S. Engineers.
IV.	Monday, "	9.—Artillery.	1st Lieut. Graham D. Fitch, U. S. Engineers.
V.	Friday, "	13.—Fortification.	Capt. F. A. Mahan, U. S. Engineers.
VI.	Monday, "	16.—Sea Coast Defense.	General H. L. Abbot, U. S. Engineers.

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ANNIVERSARY.

The Exercises of the Graduating Class were held in North Sheffield Hall on the evening of Tuesday, June 23, 1885. The candidates for degrees with the subjects of the graduation theses of the Bachelors of Philosophy are given in the following schedule. The names in the first list are of those who stood highest in their respective courses. Those marked with an asterisk read theses in the evening.

CIVIL ENGINEERS. (2.)

SAMUEL EBEN BARNEY, Ph.B., *New Haven*. Notes on the Construction of Railway Road-bed and Track.

GEORGE LEVERETT WILSON, Ph.B., *St. Paul, Minn.* On the Construction of the Conduit for the St. Paul Water-Works.

BACHELORS OF PHILOSOPHY. (70.)

*PAUL DAILY BERNARD (Select), *Brooklyn, N. Y.* On the History of the Prologue and Epilogue in the English Drama.

ROBERT NEILL BRACE (Dynamic Engineering), *Dobbs Ferry, N. Y.* On the New Croton Aqueduct.

MERRITT MEAD CLARK (Select), *Bedford, N. Y.* On the Physical Relations of Forests to the Prosperity of a Country.

*WALLACE SHERMAN CLARK (Dynamic Engineering), *Brooklyn, N. Y.* On the New Cruisers of the United States Navy.

IRVING COOK GLADWIN (Select), *Sherburne, N. Y.* On the History of English Hexameter Verse.

*JOHN VENABLE HANNA (Civil Engineering), *Kansas City, Mo.* On Railway Location.

*PERCY JACKSON (Chemistry), *Belleville, N. J.* On Pectin Bodies.

HARRY D. KOHN (Select), *Chicago, Ill.* On the History of the English Sonnet.

ALEXANDER LAMBERT, B.A. (Biology), *New York City.* On the Question whether the Liver possesses the Power of Converting Peptones into Carbohydrate Matter.

*JAMES JACOB MORGAN (Chemistry), *New Haven.* On the Determination of Lead as Sulphide.

*HARRY MCMAHON PAINTER, B.A. (Biology), *West Haven.* On the Influence of Various Therapeutic and Toxic Substances on the Amylolytic Action of Saliva.

DANIEL TUTHILL PRATT (Select), *Elmira, N. Y.* On the Development of the Liberty of the Press.

*SIDNEY ARMOUR REEVE (Dynamic Engineering), *Dayton, O.* On the Fireless Locomotive, with a Design for a Street Motor on the same Principle.

*LOUIS MILTON SCHMIDT (Dynamic Engineering), *New Britain.* On the Thomson-Houston System of Electric Lighting.

JAMES ALWARD SEYMOUR (Dynamic Engineering), *Auburn, N. Y.* On the Gaskill Pumping Engine at Saratoga Springs, N. Y.

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*William Van Schoonhoven Thorne (Select), *New York City.* On Railroad Construction in the United States between 1880 and 1883.

*George Elliot Verrill (Civil Engineering), *New Haven.* On Deep Sea Sounding.

Frederick Brewster Wheeler (Dynamic Engineering), *Monroe.* On the Theory of the Dynamo.

*Henry Howard Whitehouse (Biology), *Hartford.* On the Action of Pure Glucose and of Cinchonidine Sulphate on the Metabolism of the Body.

Arthur Bronson Adams (Civil Engineering), *New Haven.* On Underground Electric Wires and their Enemies.

Grenville French Allen (Civil Engineering), *New Haven.* Bridge Design with Working Drawings and Calculations.

Philip VanWyck Anderson (Civil Engineering), *Sing Sing, N. Y.* On the Bismarck Bridge.

James Arthur Atwood (Dynamic Engineering), *Wauregan.* On Turbine Wheels.

John Frank Babcock (Select), *Elmira, N. Y.* On the Execution of Charles I.

Clarence Blakeslee (Civil Engineering), *New Haven.* On Street Paving.

Clarence Russell Britton (Select), *Dobbs Ferry, N. Y.* On the Division of Labor as exemplified in the Wire Industries of New Haven.

Fred Spencer Bullene (Chemistry), *Kansas City, Mo.* On the Quantitative Separation of Copper and Zinc.

Arthur Chandler Coates (Select), *Kansas City, Mo.* On the Weather Signal Service of the United States.

William Ledlie Culbert (Biology), *Brooklyn, N. Y.* On the Influence of Potassium and Ammonium Bromides on the Metabolism of the Body.

John Joseph Flather (Dynamic Engineering), *Bridgeport.* On the Manufacture of Sewing Machines.

William Holt Gale (Select), *New York City.* On Infectious Pneumo-Enteritis of the Pig.

Jacob Philip Goodhart (Select), *New Haven.* On the Civil Code of the Ancient Jews.

Charles Lord Griffith (Agriculture), *San Francisco, Cal.* On Whale Fishery and the Refining of Whale Oil.

John Ethan Hill (Civil Engineering), *Mystic Bridge.* On the Sanitary Sewerage System of New Haven.

David Leavitt Hough (Dynamic Engineering), *Fort Wayne, Ind.* On Torpedoes, their History and Construction.

Edwin Young Judd (Dynamic Engineering), *Hartford.* On an Invention for the Repeating Mechanism for Clocks.

Amos William Kimball (Civil Engineering), *Portland, Or.* On the Use of Steel and Iron as Armor.

Ira Lamb (Civil Engineering), *Franklin.* On the Location of the Railroads in New Haven.

Percy Lyford Lang (Select), *Waverly, N. Y.* On Egypt and the Soudan.

William Heath Lyon, Jr. (Select), *Brooklyn, N. Y.* On the Cotton Production of the United States.

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CHARLES POND MCAVOY (Select), *Chicago, Ill.* On Beer Brewing and the Pneumatic System of Malting.

WILLIAM ADAIR MCDOWELL (Civil Engineering), *Lexington, Ky.* On Electric Lighting.

DANIEL WILLIAM MAHER (Civil Engineering), *New Haven.* On Sewers and Sewerage.

DANIEL DELEVAN MANGAM, JR. (Select), *Sing Sing, N. Y.* On the United States Life Saving Service.

WILLIAM EDWARD MARTIN (Biology), *Allentown, Pa.* On the Influence of Temperature on the Amylolytic Action of Saliva and Diastase of Malt.

EDWARD ALEXANDER MEREDITH (Civil Engineering), *Xenia, O.* On the Panama Ship Railway.

DEANE MILLER (Select), *New Rochelle, N. Y.* On Early Ships and Sailors.

HERBERT LINCOLN MITCHELL (Select), *New Haven.* On the Origin, Outbreak and Decline of Chartism.

JAMES MINOR MCGHEE (Chemistry), *Evansville, Ind.* On the General Anatomy of the Eye and its Muscles and Nerves.

WILLIAM ALPHEUS NETTLETON (Civil Engineering), *Kansas City, Mo.* On Railway Track Laying and Repairs.

TRUMAN HANDY NEWBERRY (Select), *Detroit, Mich.* On the Origin and Growth of the Bank of England.

ISAAC NORRIS, 3D (Dynamic Engineering), *Philadelphia, Pa.* An Analysis of the Mechanical Principles involved in a certain Apparatus for conveying Coal.

GEORGE WASHINGTON NORTON, JR. (Dynamic Engineering), *Louisville, Ky.* On the Theory and Use of the Steam Injector.

HENRY OLIVER (Chemistry), *Pittsburgh, Pa.* On Sulphur in Pig-Iron.

JOHN CUNNINGHAM OLIVER (Dynamic Engineering), *Pittsburgh, Pa.* On the Blast Furnace.

ABBOTT CHANDLER PAGE (Chemistry), *Fair Haven.* On the Volatility of Mercuric Chloride from Solutions.

WILLIS LAFAYETTE PERKINS (Select), *Portland, Me.* On the Selection of Food.

ROYAL WATSON PINNEY (Biology), *Derby.* On the Influence of Free and Combined Acids on the Proteolytic Action of Pepsine.

WILLARD CRAWFORD REID (Select), *Lakeville.* On Amateur Photography.

JOHN RICE (Dynamic Engineering), *Pottstown, Pa.* On the Construction of American Cable Roads.

WILLIAM TODD ROSS (Civil Engineering), *Belfast, Me.* On the Nicaragua Canal.

CHARLES GIDEON RUPERT (Civil Engineering), *New Haven.* On Geodetic Surveying.

FRANK ELBERT SANDS (Civil Engineering), *New Haven.* On Sewer Systems.

MURRAY SHIPLEY, JR. (Select), *Cincinnati, O.* On Early Dutch Trade in the East and West.

JOSEPH GODFREY SNYDACKER (Select), *Chicago, Ill.* On the Diseases of Cattle.

FRANK JEROME STEVENS (Dynamic Engineering), *New Haven.* On the Lever Escapement.

CURTIS TURNER (Dynamic Engineering), *Omaha, Neb.* (On Wheel Tests and Weir Measurements.

EDWARD SIMPSON WILSON (Biology), *New York City.* On the Germ Theory of Disease.

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BENJAMIN ELIZUR WRIGHT (Civil Engineering), *Cromwell.* On the Plattsmouth Bridge.

PRIZES.

CLASS OF 1885.

For excellence in Civil Engineering, the prize divided between JOHN VENABLE HANNA, *Kansas City, Mo.*, and GEORGE ELLIOT VERRILL, *New Haven.*

For excellence in Dynamic Engineering, the prize divided between SIDNEY ARMOUR REEVE, *Dayton, O.*, and FREDERIC BREWSTER WHEELER, *Monroe.*

For excellence in German, the prize awarded to LOUIS MILTON SCHMIDT, *New Britain.*

CLASS OF 1886.

For excellence in the Mathematics of Junior Year, the prize divided between WILLIAM DAVID JOHNSON, *New Haven*, and HENRY HAYES WADSWORTH, *Glencoe, Minn.*

Special prize for the largest collection of Plants. MARVIN D. HUBBELL, *New York City.*

CLASS OF 1887.

For excellence in all the Studies of the Freshman Year, the prize awarded to ROBERT FISHER GIBSON, *York, Pa.*, with honorable mention of EDGAR BURTON HARGER, *Oxford*, GEORGE BRINCKERHOFF RICHARDS, *New Haven*, ALFRED JOHN WAKEMAN, *Green's Farms*, EDWARD GILBERT WILLIAMS, *Essex*, and GEORGE HENRY WOOD, *Dayton, O.*

For excellence in Chemistry, the prize divided between ROBERT FISHER GIBSON *York, Pa.*, and EDGAR BURTON HARGER, *Oxford*, with honorable mention of ERWIN STARR SPERRY, *Ansonia*, and GEORGE HENRY WOOD, *Dayton, O.*

For excellence in Physics, the prize awarded to ROBERT CLAYTON AUGUR, *West Haven*, with honorable mention of ROBERT FISHER GIBSON, *York, Pa.*, and EDGAR BURTON HARGER, *Oxford.*

For excellence in Mathematics, the prize awarded to ROBERT FISHER GIBSON, *York, Pa.*, with honorable mention of ROBERT CLAYTON AUGUR, *West Haven*, and CHARLES SHERMAN JEWETT, *Buffalo, N. Y.*

For excellence in Mechanical Drawing, the prize awarded to ROBERT FISHER GIBSON, *York, Pa.*

For excellence in German, the prize divided betwen ISADORE DYER, JR., *Galveston, Texas*, ROBERT FISHER GIBSON, *York, Pa.*, CHARLES SHERMAN JEWETT, *Buffalo, N. Y.*, GEORGE BRINCKERHOFF RICHARDS, *New Haven*, and FRANK OTTO WALTHER, *Brooklyn, N. Y.*

For excellence in English Composition, 1st prize, HARRY LEON HAMLIN, *Chicago, Ill.*; 2d prizes, FRANKLIN TREAT PARLIN, *Casselton, Dakota*; GEORGE BRINCKERHOFF RICHARDS, *New Haven*; 3d prizes, HERBERT SPENCER BULLARD, *Hartford*; ARTHUR MANSFIELD EVERIT, *New Haven*; ROBERT FISHER GIBSON, *York, Pa.*; CHARLES SHERMAN JEWETT, *Buffalo, N. Y.*; OSCAR HARMON SHORT, *New York City*; FRINK MANSFIELD SMITH, *East Haven*; and EDWARD GILBERT WILLIAMS, *Essex.*

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PROGRAMME OF STUDIES

AND

CATALOGUE,

FOR THE COLLEGE YEAR, 1885-86.

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CALENDAR.

1885.		
24 Sept.	Thursday,	First Term begins.
23 Dec.	Wednesday,	First Term ends.
1886.		**Winter Vacation of two weeks.**
7 Jan.	Thursday,	Second Term begins.
21 April,	Wednesday,	Spring Recess begins.
28 April,	Wednesday,	Spring Recess ends.
29 June,	Tuesday,	Meeting of Appointing Board.
29 June,	Tuesday,	Anniversary.
30 June,	Wednesday,	Commencement.
1, 2, 3 July,	Thursday, Friday, Sat.,	Examination for Admission.
		Summer Vacation of twelve weeks.
21, 22 Sept.	Tues., Wedn.,	Examination for Admission.
23 Sept.	Thursday,	First Term begins.
23 Dec.	Thursday,	First Term ends.

ABBREVIATIONS.

S. H.	Sheffield Hall.
N. S. H.	North Sheffield Hall.
TR.	Treasury Building.
D.	Durfee College.
F.	Farnam College.
E.	East Divinity Hall.
W.	West Divinity Hall.
P. M.	Peabody Museum.
A.	Absent on leave.

In the buildings belonging to the Sheffield Scientific School, the rooms numbered from 1 to 21 are in Sheffield Hall; from 26 to 58 in North Sheffield Hall.

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REV. NOAH PORTER, D.D., LL.D.

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ARRANGED IN THE ORDER OF THEIR GRADUATION.

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Civil Engineering. (45 N. S. H.) 258 Bradley st.

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Political Economy and History. 43 Hillhouse av.

RUSSELL H. CHITTENDEN,
Physiological Chemistry. (5 S. H.) 32 Trumbull st.

* During the absence of Professor Brush in Europe for the current college year, the duties of Director will be discharged by Professor Wm. H. Brewer.

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ALBERT S. WHEELER, *German.*		Tremont House.
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HORACE L. WELLS, *Analytical Chemistry.*		14 S. H.
SAMUEL E. BARNEY, *Mathematics and Civil Engineering.*		363 Elm st.
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LOUIS V. PIRSSON, *Analytical Chemistry.*		8 Prospect pl
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ANTON PFEIFER, 55 Lock street.

JANITOR OF NORTH SHEFFIELD HALL.

GEORGE W. STODDARD, 82 Mansfield street.

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Charles Backus Ball, PH.B.,	*Washington, D. C.*,	A.
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John Bartholomew, PH.B.,	*Hudson, N. Y.*,	A.
Joseph Augustus Blake, B.A.,	*New Haven*,	134 College st.
Malcom Booth, PH.B.,	*Cheshire*,	Cheshire.
Albert Park Campbell, PH.B.,	*New Haven*,	28 York sq.
Herbert DeWitt Carrington, PH.B.,	*New Haven*,	1169 Chapel st.
George Wyckoff Cummins, PH.B.,	*Vienna, N. J.*,	297 York st.
Arnold Guyot Dana, B.A.,	*New Haven*,	24 Hillhouse av.
Henry Holbrook Gladding, PH.B.,	*New Haven*,	270 Martin st.
Duane Judson Kelsey, PH.B.,	*Killingworth*,	Killingworth.
Yung Kwai, B.A.,	*Kwongtung, China*,	318 George st.
William Ellison Lockwood, PH.B., M.D.,	*Stamford*,	146 Dixwell av.
William Wallace Nichols, PH.B.,	*Manitou Springs, Col.*	A.
Louis Valentine Pirsson, PH.B.,	*New York City*,	8 Prospect pl.
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James Alward Seymour, PH.B.,	*Auburn, N. Y.*,	114 High st.
William Tuttle Shepard, PH.B.,	*Bristol*,	17 College st.
John Prentice Terry, PH.B.,	*Brooklyn, N. Y.*,	90 High st.
George Elliot Verrill, PH.B.,	*New Haven*,	86 Whalley av.
Frederick Brewster Wheeler, PH.B.,	*Monroe*,	409 Temple st.
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Samuel Hubbard Williams, B.A., Amherst College.	*Glastonbury*,	128 High st.
Franklin Eldred Worcester, B.A., PH.B.,	*New York City*.	A.

GRADUATE STUDENTS, 24.

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Gilbert Lincoln Husted Arnold,	*Stamford*,	107 Olive st.
William Wallace Atterbury,	*Detroit, Mich.*,	389 Temple st.
Silas Warren Bartlett,	*South Orange, N. J.*	46 Elm st.
Henry William Blake,	*New Haven*,	119 w.
John Marvin Blakeley,	*St. Paul, Minn.*,	46 Elm st.
Howard Cone Bolton,	*Cleveland, O.*,	65 w.
Percival Ranney Bolton,	*Cleveland, O.*,	65 w.
Louis Whitford Bond,	*New York City*,	61 w.
Thomas Stoddard Bronson,	*New Haven*,	1460 Chapel st.
Harry Lockwood Burns,	*Milford*,	63 Prospect st.
Silas Enoch Burrows,	*Mystic*,	1010 Chapel st.
Lewis Emerson Cadwell,	*New Haven*,	106 Liberty st.
Theodore Newton Case,	*Hartford*,	287 York st.
John Chamberlain,	*Kansas City, Mo.*,	389 Temple st.
Frederick William Darlington.	*West Chester, Pa.*,	289 York st.
Alexander Harrison Davis,	*Watertown*,	116 w.
John Edwin Doane,	*Chicago, Ill.*,	36 Elm st.
Joseph Osterman Dyer,	*Galveston, Tex.*,	55 Insurance Building.
Harvey Farrington,	*Croton, N. Y.*,	64 High st.
Joseph Essex Fitzsimons,	*Waterbury*,	107 Olive st.
Robert Elder Forster,	*Harrisburg, Pa.*,	44 Elm st.
William Washington Gordon, 3d,	*Savannah, Ga.*,	43 College st.
James Eugene Greenebaum,	*Chicago, Ill.*,	63 w.
Everett Mason Grimes,	*Oakland, Cal.*,	64 High st.
Harry Cloyd Hamill,	*Georgetown, Col.*,	287 York st.
David Neil Harper,	*Shippensburgh, Pa.*,	297 York st.
Frank Sperry Harrison,	*New Haven*,	562 Chapel st.
Willis Benjamin Herr,	*Denver, Col.*,	287 York st.
Jay Russell Hickox,	*South Britain*,	270 Martin st.
William Brisbane Hickox,	*Litchfield*,	64 w.
William Barlow Hill,	*Greenfield Hill*,	17 College st.
Abraham Lincoln Howes,	*Black Rock*,	389 Temple st.
William Evelyn Hutchings,	*Louisville, Ky.*,	43 College st.
Morison Thomas Hutchinson,	*Brooklyn, N. Y.*,	36 Elm st.
Abraham Lincoln Hyde,	*New Haven*,	179 Washington st.
William David Johnson,	*New Haven*,	92 Rosette st.
Thomas Coggeshall Knowles,	*San Francisco, Cal.*,	389 Temple st.
Harrie Sheldon Leonard,	*Washington, D. C.*,	90 Wall st.
Cornelius Fay Lynde,	*Rock Island, Ill.*,	1187 Chapel st.
Mahlon Henry Marlin,	*New Haven*,	236 George st.
Frederick Anderson Marsh,	*Kansas City, Mo.*,	1187 Chapel st.
Conrad Henry Matthiessen,	*Cornwall, N. Y.*,	36 Elm st.
Edwin Frank Meyer,	*Chicago, Ill.*,	66 w.

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Henry White Patten,	*North Haven*,	36 Elm st.
George Eustis Potts,	*Philadelphia, Pa.*,	71 w.
William Acker Rice,	*St. Paul, Minn.*,	36 Elm st.
Arthur Jones Richmond,	*Providence, R. I.*,	43 College st.
Samuel Bostwick Robbins,	*Lakeville*,	119 w.
Reginald Ronalds,	*New York City*,	43 College st.
Alexander Holley Rudd,	*Lakeville*,	389 Temple st.
Henry Rustin,	*Omaha, Nebr.*,	64 High st.
Emanuel Frank Selz,	*Chicago, Ill.*,	66 w.
Edwin Coupland Shaw,	*Buffalo, N. Y.*,	389 Temple st.
William Sanders Tevis,	*San Francisco, Cal.*,	36 Elm st.
John Metcalfe Thomas,	*New York City*,	43 College st.
Calvert Townley,	*Cincinnati, O.*,	101 w.
George Pollok Devereux Townsend,	*Middletown*,	101 w.
Thomas Brodhead VanBuren, Jr.,	*Englewood, N. J.*,	43 College st.
Henry Hayes Wadsworth,	*Glencoe, Minn.*,	Allingtown.
Charles Willcox,	*Omaha, Nebr.*,	43 College st.
Rockwell Amasa Williams,	*Canterbury*,	61 Prospect st.
Willis Stoughton Williams,	*Minneapolis, Minn.*,	46 Elm st.

SENIORS, 64.

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JUNIOR CLASS.

Henry Frederick Adams,	*Westport*,	113 York st.
Robert Clayton Augur,	*West Haven*,	West Haven.
Elmer Ellsworth Bennett,	*Plainfield*,	126 High st.
Walter Pierpont Bigelow,	*New Haven*,	278 Orange st.
Herbert Spencer Bullard,	*Hartford*,	1136 Chapel st.
Lewis Alexander Burgess,	*Newark, N. J.*,	55 w.
Richard Augustus Chapman,	*Rye, N. Y.*,	64 w.
William Henry Coburn,	*Indianapolis, Ind.*,	133 College st.
Harry Fitch Coleman,	*Logansport, Ind.*,	223 York st.
Lewis Atterbury Conner,	*New Albany, Ind.*,	389 Temple st.
David Mark Cummings,	*Chicago, Ill.*,	36 Elm st.
Julius Gilbert Day,	*Seymour*,	205 Orange st.
William Greenhow Doane,	*Omaha, Nebr.*,	64 High st.
Edward Warburton Durant, Jr.,	*Stillwater, Minn.*,	43 College st.
Isadore Dyer, Jr.,	*Galveston, Tex.*,	31 Trumbull st.
Arthur Mansfield Everit,	*New Haven*,	109 Elm st.
Raymond Thomson French,	*Seymour*,	36 Elm st.
Francis Frederic Georger,	*New York City*,	36 Elm st.
Robert Fisher Gibson,	*York, Pa.*,	297 York st.
Charles Joseph Goldmark,	*New York City*,	57 w.
Wilfred Elizur Griggs,	*Waterbury*,	55 Insurance Building.
George Conradt Ham,	*Washington Hollow, N. Y.*,	44 Elm st.
Harry Leon Hamlin,	*Chicago, Ill.*,	43 College st.
Edgar Burton Harger,	*Oxford*,	150 College st.
Herbert Leopold Hart,	*Chicago, Ill.*,	63 w.
James Henry Hayden,	*New York City*,	58 w.
Joseph Cooke Jackson, Jr.,	*New York City*,	60 w.
Lawrence Bates Jenckes,	*Stamford*,	64 w.
Leonard Abbot Jenkins,	*Dresden, Saxony*,	124 w.
Charles Sherman Jewett,	*Buffalo, N. Y.*,	143 College st.
John Edwin Judson,	*New Haven*,	142 St. John st.
Frederick Sheffield Kellogg,	*Utica, N. Y.*,	43 College st.
Grayson Guthrie Knapp,	*Auburn, N. Y.*,	86 w.
Charles Wilbur Knox,	*Pittsburgh, Pa.*,	36 Elm st.
John Stewart Kulp,	*Wilkesbarre, Pa.*,	1161 Chapel st.
Isaac Eugene Leonard,	*Chicago, Ill.*,	203 York st.
Edward Linsley Maltby,	*Northford*,	297 York st.
Harry Zeller Marshall,	*Dayton, O.*,	90 Wall st.
Harley James Morrison,	*Cincinnati, O.*,	60 w.
William Partridge Ordway,	*Boston, Mass.*,	36 Elm st.
Edward Horatio Parker,	*Detroit, Mich.*,	43 College st.
Edmund Bishop Patterson,	*Allegheny City, Pa.*,	8 Prospect pl.
Frank Adelbert Paul,	*New Haven*,	27 Washington st.
Charles Eugene Phillips,	*Southington*,	14 Prospect pl.

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Frank Clark Reed,	*Pittsburgh, Pa.,*	203 York st.
Harris Smith Reynolds,	*Poughkeepsie, N. Y.,*	43 College st.
George Brinckerhoff Richards,	*New Haven,*	43 Elm st.
John Robert Wheaton Sargent,	*Chicago, Ill.,*	36 Elm st.
William Marcelin Scaife,	*Allegheny City, Pa.,*	203 York st.
Oscar Harmon Short,	*New York City,*	43 College st.
Edward Arthur Smith,	*Middletown,*	8 Prospect pl.
Frink Mansfield Smith,	*East Haven,*	East Haven.
George H. Smith,	*Canajoharie, N. Y.,*	43 College st.
Erwin Starr Sperry,	*Ansonia,*	41 High st.
Merton Pierpont Stevens,	*New Haven,*	561 Howard av.
Arthur Peale Summers,	*Colorado Springs, Col.,*	126 High st.
William Conquest Tucker,	*New York City,*	86 w.
Howard Beecher Tuttle,	*Naugatuck,*	242 York st.
Alfred John Wakeman,	*Green's Farms,*	113 York st.
Frank Otto Walther,	*Brooklyn, N. Y.,*	203 York st.
Nathaniel P. Washburn,	*Bridgewater, Mass.,*	223 York st.
Frank Warren Wentworth,	*Chicago, Ill.,*	1161 Chapel st.
Edward Gilbert Williams,	*Essex,*	47 Stanley st.
George Henry Wood,	*Dayton, O.,*	124 w.
Robert McKnight Woods,	*New Haven,*	364 George st.

JUNIORS, 66.

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FRESHMAN CLASS.

Arthur Chambers Alexander,	*Honolulu, H. I.*	59 Prospect st
John Childe Anderson,	*Sing Sing, N. Y.,*	59 w.
Joseph Albright Archbald,	*Scranton, Pa.,*	223 York st.
Gardner Ball, Jr.,	*San Francisco, Cal.,*	109 Wall st.
William Hill Bean,	*New Haven,*	40 Pleasant st.
Charles Bart Berger,	*Denver, Col.,*	201 Orange st.
George Bart Berger,	*Denver, Col.,*	201 Orange st.
Theodore Whitney Blake,	*New Haven,*	134 College st.
Marshall Latham Bond,	*New York City,*	61 w.
William Tillinghast Bull,	*Newport, R. I.,*	143 York st.
George Robert Carter,	*Honolulu, H. I.,*	107 Wall st.
William Clarke Catlin,	*Providence, R. I.,*	29 Lynwood st.
James Henry Coleman,	*New York City,*	9 Elm st.
George David Colton,	*Collinsville,*	1169 Chapel st.
John Nesbitt Conyngham,	*Wilkesbarre, Pa.,*	120 High st.
Charles Edward Curtis,	*New Haven,*	138 Dwight st.
Richard Sydney Curtiss,	*Stratford,*	59 Prospect st.
Jesse Chase Dann,	*Buffalo, N. Y.,*	421 Temple st.
Henry Lewis Davis,	*Wallingford,*	103 Wall st.
George Howard Davison,	*New York City,*	14 Lincoln st.
William Henry Davol, Jr.,	*Brooklyn, N. Y.,*	103 Wall st.
Carlton Melville DeWolf,	*New York City,*	84 Wall st.
Robert Russel Dickey,	*Dayton, O.,*	237 Orange st.
John Eufemio Dockendorff,	*Brooklyn, N. Y.,*	552 Chapel st.
John Ambrose Doolittle,	*New Haven,*	216 Orange st.
John Feeter Easterbrook,	*New Haven,*	82 York sq.
Frank Harold Farquhar,	*York, Pa.,*	114 High st.
John Ellis Field,	*Denver, Col.,*	393 Temple st.
Richard Huntington Franchot,	*Schenectady, N. Y.,*	62 w
Pedro Florentino Francke,	*New York City,*	74 High st.
Deane Funk,	*McLean, Ill.,*	395 Temple st.
Henry Kellogg Goetchius,	*New York City,*	86 Wall st.
James Douglas Gold,	*West Cornwall,*	65 Grove st.
Addison Graves,	*New London,*	56 w.
Franklin Moses Gray,	*Chicago, Ill.,*	393 Temple st.
Howard Greer, Jr.,	*Chicago, Ill.,*	6 Prospect pl.
Matthew Griswold, Jr.,	*Erie, Pa.,*	150 College st.
Stephen Benedict Grummond, Jr.,	*Detroit, Mich.,*	395 Temple st.
Fred. R. Hamlin,	*Chicago, Ill.,*	1179 Chapel st.
Charles Merritt Heminway,	*Watertown,*	237 Orange st.
Edwin Richard Hodge,	*Washington, D. C.,*	8 Prospect pl.
Noble Foster Hoggson,	*New Haven,*	126 York st.
George Snowden Howland,	*Newport, R. I.,*	117 Elm st.
Howard Livingstone Isbell,	*Union City,*	26 Ridge st., Cedar Hill.

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Harry Lydstone Johnson,	*New Haven,*	25 Eld st.
Cyrus Field Judson,	*New York City,*	61 Grove st.
George Converse Kimball,	*Hartford,*	219 York st.
Felix Kleeberg,	*New Haven,*	14 Orange st.
Edward Lambert Leeds,	*Stamford,*	295 York st.
Thomas Albert Legler,	*Dayton, O.,*	237 Orange st.
Louis LeSassier,	*New Orleans, La.,*	393 Temple st.
Edwin Hoyt Lockwood,	*New Canaan,*	59 Prospect st.
Samuel Harkness McCrea, Jr.,	*Chicago, Ill.,*	55 Trumbull st.
George Grant Mason,	*Milburn, Ill.,*	136 College st.
William Smith Mason,	*Milburn, Ill.,*	136 College st.
Charles Griffin Miller,	*New Rochelle, N. Y.,*	421 Temple st.
Charles Edward Montgomery,	*San Francisco, Cal.,*	76 Howe st.
Edward Steward Moore,	*New London,*	56 w.
Augustus Lester Moss,	*Sandusky, O.,*	62 w.
James Augustus Nelson,	*Bridgeport,*	146 York st.
Edward Marshall Ney,	*Hartford,*	154 Grove st.
Charles Norris, Jr.,	*New York City,*	150 College st.
Elbert Ellsworth Norton,	*New Haven,*	33 Pearl st.
Selden Yale Osborn,	*New Haven,*	232 York st.
Frank Wyman Parmerter,	*Plattsburgh, N. Y.,*	39 Lynwood st.
John Erskine Patrick,	*Omaha, Nebr.,*	64 High st.
Daniel Tucker Coffin Perkins,	*San Francisco, Cal.,*	82 Wall st.
Francis Cole Pratt,	*Hartford,*	223 York st.
John Goodell Prouty,	*Spencer, Mass.,*	237 Orange st.
Edwin Wright Robinson,	*New Haven,*	255 Ferry st.
Solomon Franklin Rupert,	*New Market, Va.,*	109 High st.
Henry Pinney Sage,	*New Haven.*	42 College st.
Henry Charles Schwab,	*Chicago, Ill.,*	160 Wooster st.
Charles Kirtland Shelton,	*Bridgeport,*	103 Wall st.
Shiukichi Shigemi,	*Imabari, Japan,*	330 Orange st.
Orville Emerson Sloat,	*New Haven,*	183 Wooster st.
Ernest Ellsworth Smith,	*New Haven,*	16 Hughes pl.
Percey Franklyn Smith,	*New Haven,*	4 Home pl.
Ralph Hebert Smith,	*Waterbury,*	295 York st.
Frederick William Spanutius,	*New Haven,*	180 Chestnut st.
Stanley Matthews Stagg,	*Frankfort, Ky.,*	201 Orange st.
Charles Weaver Stewart,	*Newport, R. I.,*	143 York st.
Howard Canning Taylor,	*Green's Farms,*	113 York st.
George Parker Thompson,	*New York City,*	152 Grove st.
Charles Alling Tuttle,	*New Haven,*	364 Orchard st.
Morgan Walcott,	*New York City,*	389 Temple st.
Frank Nehemiah Waterman,	*New Britain,*	35 High st.
Charles Spencer Wells,	*Southport,*	86 Whitney av.
Ralph McIntosh Wilcox,	*Portland,*	254 York st.
Hubert Kip Wood,	*Cleveland, O.,*	136 College st.
Frank Clark Woodruff,	*Orange,*	41 High st.
Albert Joseph Young,	*Evanston, Ill.,*	55 Trumbull st.

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SPECIAL STUDENTS NOT CANDIDATES FOR A DEGREE.

Joseph Stanley Brown,	*Washington, D. C.,*	S. H.
Charlotte Eliza Bush,	*New Haven,*	45 Whalley av.
Katharine Jeannette Bush,	*New Haven,*	45 Whalley av
Abner Reeder Chambers, Jr.,	*Trenton, N. J.,*	59 Grove st.
Frank Cramer,	*Appleton, Wisc.,*	112 Davenport av.
Ludwig Otterson Kellogg,	*San Francisco, Cal.,*	36 Elm st.
Francis Timothy Smith,	*Simsbury,*	7 Pearl st.
Warren A. Spalding,	*New Haven,*	89 Church st.
Francis Lewis Sperry,	*Tallmadge, Ohio,*	9 Library st.

SPECIAL STUDENTS, 9.

SUMMARY.

Graduates,	24
Seniors,	64
Juniors,	66
Freshmen,	93
Special,	9
	256

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SHEFFIELD SCIENTIFIC SCHOOL.

I.

OBJECTS.

THE SHEFFIELD SCIENTIFIC SCHOOL is devoted to instruction and researches in the mathematical, physical and natural sciences, with reference to the promotion and diffusion of science, and also to the preparation of young men for such pursuits as require especial proficiency in these departments of learning. It is one of the Departments of Yale College, like the law, medical, theological, and art schools, having its separate funds, buildings, teachers, and regulations, but governed by the Corporation of Yale College, which appoints the professors and confers the degrees. It is, in part, analogous to the academic department, or classical college, and, in part, to the professional schools.

The instruction is intended for two classes of students:—

I. Graduates of this or of other colleges, and other persons qualified for advanced or special scientific study.

II. Undergraduates who desire a training chiefly mathematical and scientific, in less part linguistic and literary, for higher scientific studies, or for various other occupations to which such training is suited.

II.

HISTORY AND ORGANIZATION.

The School was commenced in 1847. In 1860, a convenient building and a considerable endowment were given by Joseph E. Sheffield, Esq., of New Haven, whose name, at the repeated request of the Corporation of Yale College, was afterward attached to the foundation. Mr. Sheffield afterward frequently and munificently increased his original gifts.

In 1863, by an act of the Connecticut Legislature, the national grant for the promotion of scientific education (under the congressional enactment of July, 1862) was given to this department

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of Yale College. Since that time, and especially since the autumn of 1869, numerous liberal gifts have been received from the citizens of New Haven, and from other gentlemen in Connecticut, New York, and St. Louis, for the endowment of the School, and the increase of its collections.

The action of the State led to the designation by law of a State Board of Visitors, consisting of the Governor, Lieutenant-Governor, three senior Senators, and the Secretary of the State Board of Education: and this Board, with the Secretary of the Scientific School, is also the Board for the appointment of students to hold the State scholarships.

The Governing Board consists of the President of Yale College and the Professors who are permanently attached to the School. There are several other instructors associated with them, a part of whom are connected with other departments of the College.

III.

BUILDINGS AND APPARATUS.

The two buildings in which the work of instruction in the Scientific School is mainly carried on are called Sheffield Hall and North Sheffield Hall; but instruction in Mineralogy, Geology, and Biology, including Zoölogy and Comparative Anatomy, is now given entirely in the Peabody Museum and Free Hand Drawing in the Art School. These buildings contain a large number of recitation and lecture rooms, a hall for public assemblies and lectures, chemical and metallurgical laboratories, a photographical room, an astronomical observatory, museums, a library and reading room, besides studies for some of the professors, where their private technical libraries are kept.

The following is a summary statement of the collections belonging to the School:

1. Laboratories and Apparatus in Chemistry, Metallurgy, Physics, Photography, and Zoölogy.
2. Metallurgical Museum of Ores, Furnace Products, etc.
3. Agricultural Museum of Soils, Fertilizers, useful and injurious insects, etc.
4. Collections in Zoölogy.
5. Astronomical Observatory, with an equatorial telescope by Clark and Sons of Cambridge, a meridian circle, etc.
6. A collection of Mechanical Apparatus, constituting the "Collier Cabinet."
7. Models in Architecture, Geometrical Drawing, Civil Engineering, Topographical Engineering and Mechanics; diagrams adapted to public lectures instruments for field practice.

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8. Maps and Charts, topographical, geological, hydrographical, etc.

The herbarium of Professor Brewer, and the astronomical instruments of Professor Lyman, are deposited in the buildings. Professor Eaton's herbarium, near at hand, is freely accessible. Students also have access to the various laboratories and collections in Natural Science in the Peabody Museum.

Students are also admitted, under varying conditions, to the College and Society libraries, the College Reading Room, the School of the Fine Arts, and the Gymnasium.

IV.

THE LIBRARY.

The special technical library of the Scientific School consists of about five thousand volumes. Included in this is the "Hillhouse Mathematical Library" of twenty-four hundred volumes, collected during a long series of years by Dr. William Hillhouse, and in 1870 purchased and presented to the Institution by Mr. Sheffield. A catalogue of this collection forms a supplement to the Annual Report of the Governing Board of 1870. All the prominent scientific journals of this country and of Europe, together with the proceedings of foreign academies, and scientific societies, can be found either in this library or in the College Library to which students have access.

V.

INSTRUCTION FOR GRADUATE AND SPECIAL STUDENTS.

Persons who have gone through undergraduate courses of study, here or elsewhere, may avail themselves of the facilities of the School for more special professional training in the physical sciences and their applications, gaining in one, two, or three years the degree of Bachelor of Philosophy or, in two additional years of Engineering study, that of Civil Engineer or of Dynamic Engineer.

Or, engaging in studies of a less exclusively technical character, they may become candidates for the degree of Doctor of Philosophy. The instruction in such cases will be adapted to the particular needs and capacities of each student, and may be combined with that given by the graduate instructors in other departments of the University. This degree is conferred upon those who, having already taken a Bachelor's degree, engage as students in the

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Department of Philosophy and the Arts for not less than two years in assiduous and careful study. It is not given upon examination to those whose studies are pursued elsewhere. The requirements for it will in some cases exact of the student more than two years of post-graduate labor; so, especially, wherever the course of undergraduate study has been, as in the Scientific School, of less than four years. The candidate must pass a satisfactory final examination, and present a thesis giving evidence of high attainment in the branches of knowledge to which he has attended. A good knowledge of Latin, German and French will be required in all cases, unless, for some exceptional reason, the candidate be excused by the Faculty. The graduating fee is ten dollars.

Subjects likely to receive special attention are suggested as follows:

Professor LYMAN, in the use of meridional and other astronomical instruments.

Professor DUBOIS, in the principles of thermodynamics, and utilization of heat as a source of power.

Professor RICHARDS, in dynamic engineering.

Professor HASTINGS, in selected subjects in physics, and guidance in laboratory work.

Professor BRUSH, in the analysis and determination of mineral species, and in descriptive mineralogy.

Professor JOHNSON, in theoretical, analytical, and agricultural chemistry.

Professor BREWER, in agriculture and forest culture and in physical geography.

Professor CLARK, in definite integrals, differential equations, analytical mechanics, the theory of numerical approximation, with the method of least squares.

Professor EATON, in structural and systematic botany, with reference to both flowering and cryptogamous plants.

Professor ALLEN, in analytical chemistry, and in metallurgy.

Professor VERRILL, and Professor SMITH, in zoölogy and geology.

Professor CHITTENDEN, in physiological chemistry.

The same courses of study are open, for a longer or shorter time, to graduate students who do not desire to become candidates for a degree.

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Students who have taken the degree of Bachelor of Philosophy, may obtain the degree of CIVIL or of DYNAMIC ENGINEER at the end of two academical years, by pursuing the following higher course of study and professional training.

The course of study for the degree of CIVIL ENGINEER will comprise—

1. Higher Calculus. Higher Geometry. Theory of Numerical Operations.
2. Analytical Mechanics. Mechanics applied to Enigneering.
3. A Course of Construction and Design. Projects.
4. Practical Astronomy, with use of instruments, computations, etc.

This course will occupy one year.

To secure the requisite amount of professional knowledge and practice, the candidate will be required to furnish a comprehensive report of the results of an examination into the existing condition of some special line of constructive art; or to present proper evidence that he has had actual charge in the field, for several months, of construction or surveying parties, or held some responsible position deemed equivalent to this.

An elaborate design must also be submitted of some projected work of construction, based upon exact data obtained from careful surveys made by the candidate, and comprising all the requisite calculations, and the necessary detailed drawings, and accompanied by full specifications of the work to be done, and the requirements to be met by the contractor.

The fee for this degree is five dollars.

The course of study for the degree of DYNAMIC ENGINEER will comprise—

1. Higher Calculus. Higher Geometry. Theory of Numerical Operations.
2. General Principles of Dynamics (Analytical Mechanics), including special application of these Principles to Dynamic problems.
3. Construction of Machines. Designs.
4. Preparation of theses on special subjects in Dynamic Engineering.

During the second year candidates will be permitted to employ such a portion of their time as may be deemed advisable or necessary in the examination of engineering works and manufacturing establishments, and may also have the privilege of entering upon professional practice, provided it is done with the knowledge and consent of the Professor of Dynamic Engineering, and under such circumstances as shall appear to him to be favorable to professional progress.

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An elaborate thesis on some professional subject, with an original design, or project, accompanied by proper working drawings, will be required at the end of the second year.

The fee for this degree is five dollars.

SPECIAL STUDENTS.--For the benefit of those who, being fully qualified, desire to pursue particular studies without reference to the obtaining of a degree, special or irregular students are received in most of the departments of the School: not, however, in the Select Course or in the Freshman Class.

It should be distinctly understood that these opportunities are not offered to persons who are incompetent to go on with regular courses, but are designed to aid those who, having received a sufficient preliminary education elsewhere, desire to increase their proficiency in special branches.

VI.

REQUIREMENTS FOR ADMISSION AND COURSES OF INSTRUCTION FOR UNDERGRADUATE STUDENTS.

TERMS OF ADMISSION.—Candidates must be not less than fifteen years of age, and must bring satisfactory testimonials of moral character from their former instructors or other responsible persons.

For admission to the Freshman Class the student must pass a thorough examination in the following subjects:

English—including grammar, spelling and composition. In grammar, Whitney's Essentials of English Grammar, or an equivalent.

History of the United States.

Geography.

Latin—(1) Simple exercises in translating English into Latin. (Smith's "*Principia Latina*," Part I, is named as indicating the nature and extent of this requirement, and an acquaintance with it will be required unless a satisfactory substitute is offered). (2) Cæsar—six books of the Gallic War, or their equivalent. (As advantageous substitutes for the last three books of Cæsar may be suggested three books of Vergil's Æneid or a similar amount of Ovid.)

Arithmetic—Fundamental Operations, Least Common Multiple, Greatest Common Divisor, Common and Decimal Fractions, Denominate Numbers, including the Metric System of Weights and Measures; Percentages, including Interest, Discount, and Commission: Proportion, Extraction of the Square and Cube Roots.

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Algebra—Fundamental Operations, Fractions, Equations of the First Degree with one or several unknown quantities; Inequalities, Ratio and Proportion, Involution, including the Binomial Formula, for an entire and positive Exponent; Evolution, the Reduction of Radicals, Equations of the Second Degree, Progressions, Permutations and Combinations, the Method of Indeterminate Coefficients, Fundamental Properties of Logarithms, Compound Interest.

Geometry—Plane, Solid and Spherical; including fundamental notions of Symmetry, and examples of Loci and Maxima and Minima of Plane Figures.

Trigonometry—Including the Analytical Theory of the Trigometrical Functions, and the usual formulæ; the Construction and Use of Trigonometrical Tables; and the Solution of Plane Triangles; so much, for example, as is contained in Newcomb's Trigonometry to Art. 79, or in Wheeler's, or Richards's, or Wentworth's Plane Trigonometry, or in the Plane Trigonometry of Oliver, Wait and Jones. The Logarithmic and Trigonometric Tables furnished at the Examination will be Newcomb's (Henry Holt & Co., New York, 1882).

While no entrance examination is held in the *History of England*, candidates for admission are urgently advised to make themselves as familiar as possible with that subject; as a knowledge of it is essential to the most successful prosecution of some of the studies of the course.

Candidates will be allowed the option of passing on the above-named subjects in two successive years. In such cases they must present themselves for examination at the June examination of the first year in the following subjects or parts of subjects: *History of the United States, Geography, Arithmetic, Plane Geometry, and Algebra to Quadratic Equations.*

In order to have this preliminary examination counted, candidates must pass satisfactorily on four of the subjects; and notice of the intention to divide the examination must be given to Professor G. J. Brush, Director of the School, on or before June 15.

For preparation in Algebra, Geometry, and Trigonometry, the recently published text-books of Professor Newcomb (Henry Holt & Co., New York), may, without indicating undue preference, be especially recommended. And to the candidate who prepares in other works, they may serve to indicate the extent and kind of attainments expected in the prescribed topics. Candidates who prepare in the Geometry of this author, may for the present omit the short chapters on Ellipse, Hyperbola, and Parabola; though they will find it advantageous to study them.

In his preparation in GEOMETRY the candidate should, as far as practicable, have suitable exercises in proving simple theorems and solving simple problems for himself. It is important, too, that he should be accustomed to the numerical application of geometric principles, and especially to the prompt recollection and use of the elementary formulæ of mensuration. In TRIGONOMETRY he should be exercised in applying the usual formulæ to a variety of simple reductions and transformations, including the solution of trigonometrical equations. Readiness and accuracy in trigonometrical calculations are also of prime importance to the candidate. If the use of logarithms is postponed in his preparation till Trigo-

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nometry is taken up (which is by no means necessary or advisable), he should then have abundant application of them to all forms of calculation occurring in ordinary practice, as well as to those appearing in the solution of triangles. Finally, in all of his calculations, he should study the art of neat and orderly arrangement.

In LATIN the student should have such continued training in parsing as shall make him thoroughly familiar with declensions and conjugations, and with the leading principles of Syntax. To secure these results more effectually, the requirement has been adopted of simple exercises in translating English into Latin. As this course of exercises is designed solely as a preparation for reading, it should be begun at the earliest stage of Latin study. A very large proportion of the deficiencies in the Latin examination for several years past has been due to the neglect of the suggestions of this paragraph, and to the attempt to read a Latin author with totally inadequate grammatical preparation.

The examinations for admission in 1886, take place at North Sheffield Hall, on Thursday, Friday, and Saturday, July 1, 2, 3 (beginning at 9 A. M. on Thursday); and on Tuesday and Wednesday, September 21, 22 (beginning at 9 A. M. on Tuesday). Opportunities for private examinations may, in exceptional cases, be given at other times.

In 1886 examinations (for the Freshman Class only) will also be held in Andover, Mass., in Chicago, in Cincinnati, and in San Francisco (beginning on Thursday, July 1, at 9 A. M.), at places to be announced in local newspapers of the day previous. Candidates who propose to be present are requested to send their names to Professor G. J. Brush, Director of the School, before June 15. A fee of five dollars will be charged for admission to the examinations outside of New Haven.

Candidates for advanced standing in the undergraduate classes are examined, in addition to the preparatory studies, in those already pursued by the class they wish to enter. No one can be admitted as a candidate for a degree, later than at the beginning of the Senior year.

COURSES OF INSTRUCTION, occupying three years, are arranged to suit the requirements of various classes of students. The first year's work is the same for all; for the last two years the instruction is chiefly arranged in special courses.

The special courses most distinctly marked out are the following:

(*a.*) In Chemistry; (*b.*) In Civil Engineering;
(*c.*) In Dynamical (or Mechanical) Engineering;
(*d.*) In Agriculture; (*e.*) In Natural History;
(*f.*) In Biology preparatory to Medical Studies;
(*g.*) In studies preparatory to Mining and Metallurgy;
(*h.*) In select studies preparatory to other higher studies.

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The arrangement of the studies is indicated in the annexed scheme.

FRESHMAN YEAR—INTRODUCTORY TO ALL THE COURSES:

FIRST TERM—*German*—Whitney's Grammar and Reader. *English*—Lounsbury's History of the English Language; Exercises in composition. *Mathematics*—Spherical Trigonometry (Newcomb's); Plane Analytical Geometry. *Physics*—Recitations, with experimental lectures. *Chemistry*—Recitations and Laboratory practice. *Elementary Drawing*—Practical lessons, in the Art School.

SECOND TERM—*Language, Physics, and Chemistry*—as stated above. *Mathematics*—Plane Analytical Geometry, continued. *Physical Geography*—Lectures. *Botany*—Gray's Lessons, with Lectures. *Drawing*—Isometric Drawing, with application to drawing from models and structures by measurement. Shading and tinting. Principles of orthographic projection. Reading of working-drawings and isometric construction of objects from their orthographic projections. Sections.

For the Junior and Senior years the students select for themselves one of the following Courses:

(a.) IN CHEMISTRY:

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. Cooke's *Chemical Philosophy*. Roscoe and Schorlemmer's *Treatise* is required for reference. *Qualitative Analysis*—Fresenius's. *Laboratory Practice*. *Blowpipe Analysis*. *German*. *French*.

SECOND TERM—*Theoretical Chemistry*—continued. *Laboratory Practice*—Quantitative Analysis, and experimental work in Organic Chemistry. *Mineralogy*—Blowpipe Analysis and determination of species. Lectures. *French*. *German*.

SENIOR YEAR:

FIRST TERM—*Organic Chemistry*—Lectures and Recitations. *Agricultural Chemistry*—Recitations (optional). *Laboratory Practice*—Volumetric and Mineral Analysis. *Geology*—Dana's. *Zoology*—Lectures. *French*.

SECOND TERM—*Organic Chemistry*—continued. *Laboratory Practice*—Analysis of Minerals and Technical Products. *Assaying* (optional). *Geology*—Dana's. *Mineralogy* (optional). *French*.

(b.) IN CIVIL ENGINEERING:

JUNIOR YEAR:

FIRST TERM—*Mathematics*—Analytical Geometry of Three Dimensions; Elements of the Theory of Functions; Differential Calculus. *Surveying*—Field Operations. *Drawing*—Descriptive Geometry, begun. *German*. *French*.

SECOND TERM—*Mathematics*—Intergral Calculus; Rational Mechanics. *Drawing*—Descriptive Geometry, concluded. Topographical. *Surveying*—Topographical. *German*. *French*.

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SENIOR YEAR:

FIRST TERM—*Field Engineering*—Laying out Curves. Preliminary and final Location of line of Railroad, (Laying out of work), with calculations of Excavation and Embankment and Sections. Hencks's Field Book for Railroad Engineers. Searles's Field Engineering. *Civil Engineering*—Resistance of Materials. Bridges and Roofs, begun. Stone Cutting, with Graphical Problems. *Geology*—Dana's. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *French.*

SECOND TERM—*Civil Engineering*—Bridges and Roofs. Building Materials. Stability of Arches and Walls. Mahan's Civil Engineering. *Dynamics*—Principles of Mechanism. Steam Engine. *Hydraulics*—Hydraulics and Hydraulic Motors. *Drawing*—Designing of Engineering Structures. *Astronomy*—Loomis's Astronomy, with practical problems. *Mineralogy*—continued. *Geology*—Dynamic. *French.*

(c) IN DYNAMIC ENGINEERING:

JUNIOR YEAR:

FIRST TERM—*Mathematics*—Analytical Geometry of Three Dimensions: Elements of the Theory of Functions; Differential Calculus. *Surveying*—Field Practice. *Principles of Mechanism*—Kinematics. *Shop Visiting*—Sketching Machine Details and Tools. *Drawing*—Descriptive Geometry, begun. *German. French.*

SECOND TERM—*Mathematics*—Integral Calculus; Rational Mechanics. *Principles of Mechanism*—Applied Kinematics; Transmission of Power by Belts and Gearing; Forms of Teeth of Wheels; Cams; Parallel Motions, etc. *Shop Visiting*—continued. Sketching Machinery and Study of Mechanical Processes. *Study of Steam Engine*—begun. *Drawing*—Descriptive Geometry, concluded; Perspective and Shadows; Machine Details.

SENIOR YEAR:

FIRST TERM—*Applied Mechanics*—Friction; Moment of Inertia; Centrifugal Force: Elasticity and Strength of Materials; Strains in Structures; Theory of Flexure and Torsion; Construction of Roofs and Bridges; Equilibruim and Pressure of Fluids; Theory of Flotation; Flow of Fluids in pipes and channels; Resistance of Ships. *Machine Designing*—Practical Exercises in Designing Machine Details and Simple Machines. *Study of the Steam Engine*—continued. *Shop Visiting*—Inspection of Machines and Study of Processes; Reports of Visits.

SECOND TERM—*Hydrodynamics*—Theory of Water-Wheels, Turbines, and Water Pressure Engines. *Thermodynamics*—General principles of Heat employed as a source of power; Theory of the Steam Engine; Hot Air Engines; Gas Engines. *Machine Designing*—continued. Practical Exercises in designing Machinery for Shaping Metals, Hoisting, Pumping, etc. Designs and Working Drawings of Steam Engines and Boilers; Estimates of Weight and Cost of Machinery. *Shop Visits and Reports.*

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(d.) IN AGRICULTURE:

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. *Qualitative Analysis*—Fresenius's. *Laboratory Practice. Blowpipe Analysis. German. French.*

SECOND TERM — *Theoretical Chemistry* — continued. *Laboratory Practice*—Quantitative Analysis. *Mineralogy*—Blowpipe Analysis and Determination of Species. *Physiology*—Huxley's. *Botany. French. German.*

SENIOR YEAR:

FIRST TERM—*Agriculture*—Cultivation of the Staple Crops of the Northern States. Tree Planting and Forestry. *Agricultural Chemistry* — Johnson's. *Organic Chemistry* — Lectures and Recitations. *Geology* — Dana's. *Botany. Zoology. English. French.*

SECOND TERM—*Agriculture*—Laws of Heredity and Principles of Breeding; Lectures. *Geology*—Dana's. *Rural Economy*—Systems of Husbandry. *Agricultural Chemistry*—Johnson's. *Organic Chemistry*—continued. *Geology*—Dana's. *Zoology. Microscopy. English. French.*

(e.) IN NATURAL HISTORY:

(Either Geology, Mineralogy, or Zoology, Botany, may be made the principal study, some attention in each case being directed to the other three branches of Natural History.)

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. *Qualitative Analysis*—Fresenius's; Laboratory Practice; Recitations. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *Botany*—Gray's Manual; Laboratory Practice. *German. French.*

SECOND TERM—*Zoology*—Laboratory Practice; Recitations; Excursions (land and marine). *Botany*—Laboratory Practice; Excursions. *Physiology*—Huxley's. *Mineralogy*—continued. *Physical Geography. German. French.*

SENIOR YEAR.

FIRST TERM—*Geology*—Dana's; Excursions. *Zoology*—Laboratory Practice; Lectures; Recitations; Excursions. *Botany*—Herbarium Studies; Gray's Textbook; Excursions. *French.*

SECOND TERM—*Geology*—Dana's. *Anatomy of Vertebrates*—Huxley's. *Zoology* — Laboratory Practice; Recitations; Lectures. *Botany* — Herbarium Studies, especially in the Cryptogamous Orders; Botanical Literature; Essays in Descriptive Botany. *Meteorology. French.*

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Besides the regular courses of recitations and lectures on structures and systematic Zoölogy and Botany, and on special subjects, students are taught to prepare, arrange, and identify collections, to make dissections, to pursue original investigations, and to describe genera and species in the language of science. For these purposes, large collections in Zoölogy and Palæontology belonging to the College are available, as are also the private botanical collections of Professor Eaton.

(f.) IN BIOLOGY PREPARATORY TO MEDICAL STUDIES:

JUNIOR YEAR:

FIRST TERM—*Theoretical Chemistry*—Lectures and Recitations. Cooke's *Chemical Philosophy*. Roscoe and Schorlemmer's Treatise is required for reference. *Qualitative Analysis*—Fresenius's; Laboratory Practice; Recitations. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy. *German*. *French*.

SECOND TERM—*Anatomy and Histology*—Laboratory Practice, Lectures and Recitations. *Physiology*—Huxley's; Practical Exercises. *Embryology*—Lectures. *Theoretical Chemistry*—continued. *Mineralogy*—continued. *Botany*—Lectures; Practical exercises in Phenogamous Plants; Excursions. *German*. *French*.

SENIOR YEAR:

FIRST TERM—*Physiological Chemistry*—Recitations, Laboratory Practice, and Lectures. *Organic Chemistry*—Lectures and Recitations. *Zoölogy*—Lectures. *Botany*—Practical exercises, Lectures, and Excursions. *Geology*—Dana's. *French*.

SECOND TERM—*Physiological Chemistry*—continued. *Experimental Toxicology*. *Geology*—Dana's. *Zoölogy*—Lectures. *Sanitary Science*—Lectures. *Laws of Heredity and Principles of Breeding*—Lectures. *French*.

(g.) IN STUDIES PREPARATORY TO MINING AND METALLURGY:

Young men desiring to become Mining Engineers can pursue the regular Course in Civil or Mechanical Engineering, and at its close can spend a fourth year in the study of metallurgical chemistry, mineralogy, etc.

(h.) IN THE SELECT STUDIES PREPARATORY TO OTHER HIGHER STUDIES.

JUNIOR YEAR.

FIRST TERM—*Mineralogy*—Blowpipe Analysis and Determinative Mineralogy *Physical Geography*—Guyot; Lectures. *English*—Early English. *History*—Green's Short History of the English People. *French*. *German*.

SECOND TERM—*Mineralogy*—Lectures. *Astronomy*. *Botany*—Lectures; Excursions; Laboratory Practice. *English*—Chaucer, Bacon, Shakspere. *History*—Green's History, continued. *German*. *French*.

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SENIOR YEAR:

FIRST TERM—*Geology*—Recitations and Excursions *Zoölogy*—Lectures and Excursions. *Linguistics*—Whitney's Life and Growth of Language. *English*—Shakspere. *Constitutional Law of the United States. French.*

SECOND TERM—*Geology*—continued. *Meteorology*—Lectures. *Sanitary Science*—Lectures. *Political Economy*—Recitations and Lectures. *English*—Shakspere, Milton, Dryden, Pope, Gray, and later authors. *French.*

Exercises in English Composition are required during the entire course from all the students. The preparation of graduating theses is among the duties of the Senior Year.

Lectures on Military Science and Tactics are annually given by General Abbot, and other officers of the Engineer Corps of the United States Army.

DRAWING.—The course in drawing extends through the three years. During the first term of Freshman year, the students practice free-hand drawing at the Art School building, under the direction of Professor Niemeyer, of the Yale School of the Fine Arts. After the completion of the course in free-hand drawing, instruction is given by Mr. F. R. Honey, during the second term, in the elementary principles of instrumental drawing, embracing Elementary projection drawing, Isometric drawing, and Descriptive Geometry as far as warped Surfaces. This course is obligatory upon all.

During the Junior and Senior years, instruction in drawing is obligatory only on the students in Civil and Mathematical Engineering. In the former year the system of instruction embraces shades and shadows, tinting, perspective, and warped surfaces. By this method all the problems in Descriptive Geometry are required to be worked out on the drawing-board instead of the black-board. The course extends through the entire year, and is under the direction of Mr. Honey.

In Senior year, students are required to apply the principles of drawing already obtained to works of construction, under the general supervision of the Professors of Civil and of Dynamic Engineering.

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VII.

METHODS OF INSTRUCTION.

The instruction in this institution is given chiefly in small class-rooms, in connection with recitations and by familiar lectures, illustrated by the apparatus at the command of the various teachers. In many studies weekly excursions are made for the purpose of collecting specimens and examining natural phenomena.

In Chemistry and Metallurgy the students work several hours daily in well-appointed laboratories, under the direct superintendence of the instructors, and are guided through systematic courses of quantitative and qualitative analysis, assaying, and the blow-pipe determination of minerals and ores.

In the course in Biology, instruction in Comparative Anatomy and Histology is given in the laboratory five or six mornings each week; the student working out for himself, by dissection and the examination of preparations, the anatomy of several types of animals, and making a large part of the microscopical preparations used in the study of the different tissues. In Physiological Chemistry the student works four hours daily in the study of the chemical processes of the body and in the preparation and examination of the more important proximate principles; thus, under the head of nutrition the various digestive processes are successively studied, artificial digestions are made, the products are separated and examined, while their physiological functions are demonstrated by experiments on animals. Special attention is also paid to the micro-chemistry of the various tissues. Students are likewise trained in qualitative and quantitative analysis of urine, both in health and disease, not alone for the practical results to be obtained, but especially for the means which it affords of studying the metabolic changes of the body. Toxicology is taught by experiments on animals; the absorption and elimination of poisons, together with other points of physiological value, being demonstrated by chemical analysis of tissues and secretions. In each of these subjects laboratory instruction is supplemented by recitations and lectures.

In Botany, during the summer of Junior year, exercises in analyzing and identifying plants occur two or three times a week, followed by practice in writing characters and descriptions of plants from living specimens. Students are shown also the best

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methods of collecting and preserving for future study, specimens of Flowering Plants, Ferns, Mosses, Algæ, etc. In the autumn term of Senior year the work of the summer is continued. Students are encouraged to pursue special lines of Botanical investigation, and varied assistance is rendered them according to their needs. The final examination is intended to show what they have learned, and the collections they have made are considered to be of minor importance.

In Zoölogy excursions are made during the Summer term of Junior and Fall term of Senior year, in company with the instructors, for the purpose of observing the habits and making collections of marine, fresh-water, and terrestrial animals of all classes. Each student is required to prepare and present for examination a collection containing a specified number of species, and illustrating the various classes of animals. He must also be able to pass an examination upon his collection, at least to the extent of explaining the classes and orders illustrated, and showing why particular specimens belong to the respective classes.

In Geology excursions are made for the purpose of examining geological phenomena and making special collections of rocks and minerals. Each student is required to pass a satisfactory examination on his collection at the end of the first term of Senior year.

In Civil Engineering the students, besides attending on Class recitations and lectures, pursue a systematic course of exercises in the different branches of Geometrical Drawing and Graphical Statics, and in the application of the principles of drawing to works of construction; and have good practice in the operations of Surveying and Field Engineering—acquiring facility in the use and adjustment of Surveying and Engineering Instruments. In Topographical Surveying they are instructed in the use of the Plane Table for topographical work, and are required to prepare a detailed chart of the ground surveyed—exhibiting the contour lines and all its topographical features. Numerous problems of computation, and graphical exercises, are included in the Course of Construction pursued in the Senior year. A course of Blowpipe Analysis is also taken by the Senior Class, that a more thorough knowledge may be gained of minerals and building stones.

In Dynamic Engineering the method of instruction is by recitation and lectures, supplemented by work in the drawing room, by shop visits, and visits of inspection in and out of the city, and

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by tests with the indicator and dynamometer. The lectures are illustrated by models, by large cartoons adapted for the purpose, and by the complete collection of working drawings of the Novelty Iron Works, owned by the School. In the drawing room, detailed working drawings of various machines are made. A general sketch of the proposed machine is given and complete detailed working drawings are required, in proper shape for the pattern-maker or machinist. The student is taught the best practise, and his judgment is trained in choosing relative proportions. The student is required to describe the steps to be followed in building the machine, and to make as nearly as possible an estimate of its cost. Pattern, foundry, blacksmithing and machine work are studied in detail. In the visits, machinery and processes are critically examined in detail, and sketches of important machines with written descriptions are required.

In addition to the above, a course of lectures is given every winter by the professors of the schools and others, on topics of popular interest.

VIII.

TUITION CHARGES.

The charge for tuition for undergraduate students is $150 per year, payable, $55 at the beginning of the first and of the second term, and $40 at the middle of the second term. The student in the Chemical course has an additional charge of $70 per annum for chemicals and use of apparatus. He also supplies himself at his own expense with gas, flasks, crucibles, etc., the cost of which should not exceed $10 per term. A fee of $5 is charged members of the Freshman Class for chemicals and materials used in their laboratory practice, and the same fee is required from all (except Chemical students) who take the practical exercises in Blow-pipe Analysis and Determinative Mineralogy. A fee of $5 a term will also be charged to the students in the Zoölogical laboratory, for materials and use of instruments. An additional charge of $5 is annually made to each student for the use of the College Reading Room and Gymnasium.

For graduate students the charge for tuition is $100 per year.

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IX.

CHURCH SITTINGS.

Free sittings for students in this department of Yale College are provided as follows: in the Center Church (Congr.); in the Trinity (Episc.); and in the First Methodist Church.

Those who prefer to pay for a sitting for a year, more or less, in the churches above mentioned, or in any other church of any denomination, will be aided on application to the Secretary of the School.

Sittings in the Gallery of the College Chapel are free as heretofore to the students of this department.

X.

DEGREES.

Students of this department, on the recommendation of the Governing Board, are admitted by the Corporation of Yale College to the following degrees. They are thus conferred:

1. BACHELOR OF PHILOSOPHY: on those who complete any of the three-years courses of study, passing all the examinations in a satisfactory manner, and presenting a graduation thesis.

The fee for graduation as Bachelor of Philosophy, including the fee for Triennial Catalogues, Commencement Dinners, etc., is $10; unless the person taking the degree is also an academical graduate, when it is but $5.

2. CIVIL ENGINEER and DYNAMICAL ENGINEER: The requirements for these degrees are stated on page 37.

3. DOCTOR OF PHILOSOPHY: The requirements for this degree are stated on page 35.

XI.

TERMS AND VACATIONS.

The next academic year begins Thursday, September 23, 1886. The first term begins twelve weeks from Commencement-day and continues thirteen weeks: the second term begins regularly on the first Thursday in January and continues until Commencement-day, with a spring recess—usually of eight days—including Easter. (See Calendar, p. 20.)

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XII.

ANNOUNCEMENT IN RESPECT TO STATE STUDENTS.

The scholarships established in this School in consequence of the bestowal upon it of the Congressional grants are designed to aid young men who are in need of pecuniary assistance in fitting themselves for agricultural and mechanical pursuits of life. All applicants must be citizens of Connecticut. In case there are more applicants than vacancies, candidates will be preferred who have lost a parent in the military or naval service of the United States, and next to these such as are most in need of pecuniary assistance; and the appointments will be distributed as far as practicable among the several counties in proportion to their population. The appointing Board for the current year, consisting of the Board of Visitors of the State and the Secretary of the School, will meet on June 29, 1886, and at or about the same time in the year 1887, due notice of which will be given by publication in every county in the State. All applications should be made previous to that time. Blank forms for application will be sent, when requested, by Professor GEORGE J. BRUSH, Secretary of the Appointing Board.

XIII.

ANNIVERSARY.

The Anniversary of the School is held on Tuesday of the Commencement week in Yale College, when selections from the graduation theses are publicly read. The degrees are publicly conferred by the President and Fellows of Yale College on Commencement Day.

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APPENDIX I.

ENTRANCE EXAMINATION PAPERS.

The following are the papers for 1885, upon which applicants for admission were examined at the June and September examinations.

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ARITHMETIC.

JUNE, 1885.

1. Find the greatest common divisor and the least common multiple of 9249 and 10920.

2. Divide $\frac{2}{3}$ of $7\frac{3}{4}$ by $\frac{4}{5}$ of $11\frac{4}{11}$.

3. Divide 10.85 by 0.0775.

4. A merchant sold a lot of flour at $8.40 per barrel and thereby gained 20 per cent. He afterward sold another lot of the same flour for $203 and thereby gained 16 per cent. How many barrels were there in the last lot?

5. A sends B $5000, with which B is to purchase lumber after providing for his commission at 2 per cent. How much will B have to expend for lumber and what will be the amount of his commission?

6. Extract the square root of 0.001 to the fourth decimal place.

7. Give the table of Troy weights and that of metric weights. How is the gram determined? About what is its value in grains?

ARITHMETIC.

SEPTEMBER, 1885.

1. Resolve 2346 into its prime factors.

2. Add $\frac{4}{7}$ of $18\frac{3}{11}$ and $\frac{11}{12}$ of $\frac{4}{5}$ of $6\frac{3}{11}$.

3. What decimal part of a degree is 52′ 43″.5?

4. If $9\frac{1}{4}$ yds. of cloth cost $23\frac{1}{8}$, how many yards can be bought for $38\frac{7}{16}$?

5. At what rate per cent. per annum, simple interest, will $350 amount to $423.50 in 5 yrs. 3 mos.?

6. The area of a square is 655.36 square feet; what is the length of its side?

6. A cubical vessel contains 1331 liters; what is the length of its edge in meters?

PLANE GEOMETRY.

JUNE, 1885.

[NOTE.—State at the head of your paper what text-book you have studied on the subject and to what extent.]

1. Prove that if in any triangle one side be greater than another, the angle opposite that side will be greater than the angle opposite the other.

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2. Determine how many sides the polygon has the sum of whose interior angles is equal to the sum of its exterior angles. Explain your method.

3. (*a*) How does the perpendicular from the center of a circle upon a chord divide the chord and the arc which it subtends? (*b*) How is an angle inscribed in a circle measured? (*c*) How is each angle between two intersecting chords of a circle measured? (*d*) What is the locus of the center of a circle whose circumference passes through two given points? Give proof of your answer.

4. Divide a given finite straight line into any given number of equal parts and prove your construction.

5. Given two arcs of circles of 30° whose radii are 1 ft. and 2 ft. respectively; compare their lengths and the areas of the corresponding sectors; and calculate the length of the first and the area of its corresponding sector.

6. If two sides of a triangle be given, what angle will these sides form when its area is a maximum? Give proof.

SOLID AND SPHERICAL GEOMETRY.

JUNE, 1885.

[NOTE.—State what text-book you have studied on the subject and to what extent.]

1. If a line intersect a plane it makes a less angle with its projection on the plane than with any other line in the plane passing through the point of intersection.

2. The sum of any two face angles of a trihedral angle is greater than the third.

3. Define a regular polyhedron. How many regular polyhedrons are there? Give their names and define each of them.

4. All lines tangent to a sphere from the same external point are equal and touch the sphere in a circle of the sphere.

5. Define a conical surface and a cylindrical surface.

6. The volume of a cone is V; what is the volume of a similar cone whose surface is n times as great?

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GEOMETRY.

SEPTEMBER, 1885.

[NOTE.—State what text-book you have studied on the subject and to what extent.]

1. Prove that two triangles are equal when the three sides of the one are equal respectively to the three sides of the other.

2. A straight line cannot intersect the circumference of a circle in more than two points.

3. Upon a given straight line to describe a segment which shall contain a given angle.

4. Define similar polygons and prove that the perimeters of two similar polygons are to each other as any two homologous sides.

5. The height of a room is ten feet; how can a point in the floor directly under a given point in the ceiling be determined with a twelve-foot pole?

6. If two straight lines be cut by three parallel planes, their corresponding segments are proportional.

7. Find the volume of a regular tetrahedron whose edge is E.

8. Find the area of a spherical triangle whose angles are 65°, 75°, 80°, the radius of the sphere of which it forms a part being 10 feet.

ALGEBRA TO QUADRATICS.

JUNE, 1885.

[NOTE.—State at the head of your paper what text-book you have studied on the subject and to what extent.]

1. Resolve the following expressions into factors: a^3-8b^3; a^3+27b^3; a^4-81b^4; $4a^{4m}-4a^{2m}b^n+b^{2n}$.

2. Divide $\frac{x}{1+x}+\frac{1-x}{x}$ by $\frac{x}{1+x}-\frac{1-x}{x}$ and express the quotient in its simplest form.

3. Given $\frac{ax}{a-b}+4b=\frac{cx}{3a+b}$ to find the value of x.

4. Given $\frac{1}{x}+\frac{2}{y}=a$ and $\frac{3}{x}+\frac{4}{y}=b$ to find the values of x and y.

5. Simplify the following expressions:

$\sqrt{108}-\sqrt{72}$; $(2+3\sqrt{5})(3\sqrt{5}-2)$; $\sqrt[3]{a^6x^{12}}$; $\sqrt{a+b}\times\sqrt{a-b}$.

6. Reduce $\sqrt{\frac{a+6}{a-6}}$ to a fraction having a rational denominator.

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ALGEBRA FROM QUADRATICS.

JUNE, 1885.

[NOTE.—State at the head of your paper what text-book you have studied on the subject and to what extent.]

1. Given $\frac{x+2}{x-1} - \frac{4-x}{2x} = \frac{7}{3}$ to find the value of x.

2. Form a quadratic whose roots shall be 3 and $-\frac{2}{7}$.

3. Given $x^2+y^2=436$ and $x-y=14$ to find the values of x and y.

4. Given the first term a, the ratio r, and the number of terms n, of a geometric progression, to deduce a formula for the sum of the progression.

5. How many different products of 2 factors can be formed from n different numbers?

6. Expand $\frac{3+2x}{5+6x}$ into a series of ascending powers of x by the method of indeterminate coefficients.

ALGEBRA.

SEPTEMBER, 1885.

[NOTE.—State at the head of your paper what text-book you have studied on the subject and to what extent.]

1. Simplify $\dfrac{\dfrac{a^2+b^2}{b} - a}{\dfrac{1}{b} - \dfrac{1}{a}} \times \dfrac{a^2-b^2}{a^3+b^3}$.

2. Given $\frac{x}{a} + \frac{y}{b} = c$ and $\frac{ax}{by} = -c$ to find the values of x and y.

3. Write four terms of the development of $\left(1 + \frac{a}{x^2}\right)^n$.

4. (1) Write equivalent expressions for a^0b^{-m}, $\sqrt[3]{a^2}$, $a^{\frac{3}{2}}$.

   (2) Simplify $\sqrt{12} \times \sqrt[3]{72}$; $\sqrt[4]{49}$; $\sqrt[3]{8x^6}$; $\sqrt[5]{54} + \sqrt[3]{128}$.

5. Given $3 - \sqrt{x^2-1} = 2x$ to find the values of x.

6. Resolve $3x^3-6x+10$ into factors.

7. Given $x^2+xy=15$ and $xy-y^2=2$ to find the values of x and y.

8. If each of n straight lines intersects all the others, not more than two lines intersecting in the same point, how many points of intersection will there be?

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9. Find the value of the repeating decimal $0.72525+$

10. Develop $\frac{1+x}{2+3x}$ into a series by the method of indeterminate coefficients (four terms of the series will suffice).

TRIGONOMETRY.

JUNE, 1885.

[State what text-book you have studied on the subject and to what extent.]

1. Describe the different ways of measuring angles in Trigonometry. How many degrees are there in the angle $\frac{\pi}{6}$?

2. Define the sine, tangent and secant of an angle and represent each by a straight line.

3. How many angles are there having the same given function, sine, tangent, etc.? Name five angles having the cosine $\frac{1}{2}$.

4. Show that $\sin(\pi+\varphi) = -\sin\varphi$; also that

$$\tan\left(\frac{\pi}{2}+\varphi\right) = -\cot\varphi.$$

5. Given $\tan\varphi = \frac{m}{n}$ to find $\sin\varphi$ and $\cos\varphi$.

2. Show that $\cos 2\varphi = \cos^2\varphi - \sin^2\varphi = 1 - 2\sin^2\varphi$; also $\sin\frac{1}{2}\varphi = \sqrt{\frac{1}{2}(1-\cos\varphi)}$

7. In a triangle A B C given $A = 120° 10'$, the side a (opposite A) $= 4256.6$, the side b (opposite B) $= 2267.8$ ft. to find the remaining parts of the triangle. Is there more than one solution possible with these data?

TRIGONOMETRY.

SEPTEMBER, 1885.

[Note.—State what text-book you have studied on the subject and to what extent.]

1. Give the algebraic signs of the different trigonometrical functions for an angle terminating in each of the four quadrants.

2. Express the sine, tangent and secant of $\frac{1}{2}\pi - \alpha$ in functions of α.

3. Find the value of $\tan\alpha$ in terms of $\sin\alpha$.

4. Show that $\tan\left(\frac{\pi}{4} - \alpha\right) = \frac{1-\tan\alpha}{1+\tan\alpha}$.

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5. a, b, c, being the sides of triangle ABC respectively opposite the angles A, B, and C, show that

$$\frac{\tan\frac{1}{2}(A-B)}{\tan\frac{1}{2}(A+B)} = \frac{a-b}{a+b}.$$

What is this formula used for?

6. In the triangle ABC, given the sides BC = 2575 ft., AC = 2560.7 ft., AB = 2601.6 ft.; to find the angle A.

ENGLISH GRAMMAR.

JUNE, 1885.

1. Name the relative pronouns. State the distinction in their use, and give the rule for the agreement of the relative with the antecedent.

2. State the difference between the strong (or old) and the weak (or new) conjugation of the English verb, and give three illustrative examples of each.

3. Parse the following sentence:

He lived long enough to see those who had been his enemies become his friends.

ENGLISH.

1. What are the two methods of comparison of the adjective? Compare the adjectives that are compared irregularly.

2. State the distinction between the strong, or old, and the weak, or new, conjugation of the English verb, and give three illustrative examples of each.

3. Parse the following sentence:

What was thought of his conduct was a subject about which he gave himself no concern.

CAESAR.

JUNE 25, 1885.

I. Translate as literally as possible:

1. Divitiăcus respondit: *Hoc* esse miseriorem gravioremque *fortunam* Sequanōrum quam reliquorum, quod *soli* ne in occulto quidem queri neque auxilium implorare auderent, absentisque

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Ariovisti crudelitatem, velut si coram adesset, horrerent, propterea quod *reliquis* tamen fugae facultas daretur, *Sequānis* vero, qui intra fines suos Ariovistum recepissent, quorum oppida omnia in potestate ejus essent, omnes cruciatus essent perferendi.

2. At totis fere a fronte et ab sinistrā parte nudatis castris, quum in dextro cornu legio duodecima et non magno ab eā *intervallo* septima constitisset, omnes Nervii, confertissimo *agmine*, *duce* Boduognāto, qui summam imperii tenebat, ad eum locum contenderunt; quorum pars aperto *latere* legiones circumvenire, pars summum castrorum locum petere coepit.

3. Quo proelio bellum Venetōrum totiusque orae maritimae confectum est. Nam quum omnis juventus, omnes etiam gravioris *aetatis*, in quibus aliquid *consilii* aut dignitatis fuit, *eo* convenerant, tum *navium* quod ubique fuerat, unum in locum coēgerant; quibus amissis, reliqui neque quo se reciperent neque quemadmodum oppida defenderent, habebant.

4. Navibus circiter octoginta onerariis *coactis contractis*que, quot satis esse ad duas transportandas legiones existimabat, quod praeterea navium longarum habebat, quaestori, legatis, praefectisque *distribuit*. Huc accedebant octodecim onerariae naves, quae ex eo loco ab millibus passuum octo vento *tenebantur*, quo minus in eundem portum *pervenire possent*.

5. His aliquantum itineris *progressis*, quum jam extremi essent in prospectu, equites a Quinto Atrio ad Caesărem *venerunt*, qui nuntiarent, superiore nocte, maximā *coortā* tempestate, prope omnes naves afflictas atque in litore *ejectas* esse; quod neque ancorae funesque subsisterent, neque nautae gubernatoresque vim tempestatis *pati* possent.

6. At ii, qui in jugo constiterant, nullo etiam nunc usu rei militaris *percepto*, neque in eo, quod probaverant, consilio *permanere*, ut se loco superiore *defenderent*, neque eam quam *prodesse* aliis vim celeritatemque *viderant*, imitari potuerunt; sed se in castra recipere *conati* iniquum in locum demiserunt.

II. *Grammatical questions, supplementary to the paper on Latin Grammar:*

1. State the construction of all italicized words in passages 1, 2, and 3.

2. Give the principal parts of all italicized words in passages 4, 5, and 6.

3. Quote from the text an example of indirect statement and rewrite it so as to make it direct.

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LATIN. (EXERCISES AND GRAMMAR.)

JUNE 25, 1885.

I. *Translate into Latin:*

1. The enemy[1] (pl.) take-a-position[2] at-the-foot-of[3] the mountain.[4]

2. The enemy will take a position at the foot of the mountain.

3. Caesar was informed[5] that the enemy had taken a position at the foot of the mountain. (*Give two versions, one of them illustrating direct statement.*)

4. The lieutenant[6] sends[7] a messenger to inform Ceasar that the enemy have taken a position at the foot of the mountain.

5. When battle[8] had been joined[9] (*abl. abs.*) the Gauls endeavored[10] to break through[11] the line[12] of the Romans.

6. The Gauls form the plan of breaking through the line of the Romans.

7. The line of the Romans was broken through by the Gauls.

8. Cæsar hastens[13] into the territory[14] of the Nervii to anticipate[15] their plans[16].

9. Cæsar hastened into the land of the Nervii to anticipate their plans.

10. Cæsar lived many years in Gaul and died at Rome.

[1]hostis.	[5]certior fieri.	[9]committĕre.	[13]contendĕre.
[2]considĕre.	[6]legatus.	[10]conāri.	[14]ager. (Use pl.)
[3]sub.	[7]mittĕre.	[11]perrumpĕre.	[15]praevenīre.
[4]mons.	[8]proelium.	[12]acies.	[16]consilium.

II. *Latin Grammar:*

1. Decline *urbs, dies, facilis, major.*

2. Decline *tu, qui, alius.*

3. Compare *altus, felix, facilis, multus, fortiter, bene, maxime.*

4. Give the synopsis, both active and passive, of *vinco* (*vincere, vici, victum*), and *do* (*dăre, dedi, datum*).

5. Give the rules for the government of cases by prepositions.

CAESAR.

SEPTEMBER 22, 1885.

I. *Translate as literally as possible:*

Ad haec Ariovistus respondit: *Jus* esse belli, ut, qui vicissent, *iis*, quos vicissent, quemadmodum vellent, imperarent: item populum Romānum victis non ad alterius praescriptum, sed ad

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suum arbitrium *imperare* consuesse. Si ipse *populo* Romāno non praescriberet, quemadmodum suo *jure* uteretur, non oportere sese a populo Romāno in suo jure impediri.

2. Quibus omnibus *rebus* permoti equites Trevĭri, quorum inter Gallos virtutis opinio est singularis, qui auxilii causā ab civitate ad Caesărem missi venĕrant, quum *multitudine* hostium castra nostra compleri, nostras legiones premi et paene circumventas teneri, calones, equites, funditores, Numĭdas, diversos dissipatosque in omnes partes *fugere* vidissent, desperatis nostris rebus, *domum* contenderunt.

3. Eodem fere tempore Publius Crassus, quum intelligeret in his locis *sibi bellum* gerendum, ubi paucis ante *annis* Lucius Valerius Praeconīnus *legatus* exercitu pulso interfectus esset, atque unde Lucius Mallius proconsul impedimentis amissis profugisset, non mediocrem *sibi* diligentiam adhibendam intelligebat.

4. Exiguā parte aestatis reliquā, Caesar, etsi in his locis, quod omnis Gallia ad septemtriones *vergit* maturae sunt hiemes, tamen in Britanniam *proficisci* contendit, quod omnibus fere Gallĭcis bellis hostibus nostris inde subministrata auxilia *intelligebat;* et si tempus anni ad bellum *gerendum deficeret*, tamen magno sibi usui fore *arbitrabatur*, si modo insulam adisset et genus hominum *perspexisset*, loca, portus, aditus *cognovisset.*

5. Caesar, *exposito* exercitu et loco castris idoneo capto, ubi ex captivis cognovit, quo in loco hostium copiae consedissent, cohortibus decem ad mare relictis et equitibus trecentis, qui praesidio navibus essent, de tertiā vigiliā ad hostes contendit, eo minus *veritus* navibus, quod in litore molli atque aperto deligatas ad ancoram *relinquebat.*

6. Segni Condrūsique, ex gente et numero Germanōrum, qui sunt inter Eburōnes Trevĭrosque, legatos ad Ceasărem miserunt, *oratum*, ne se in hostium numero duceret neve omnium Germanōrum, qui essent citra Rhenum, unam esse causam judicaret; nihil se de bello cogitavisse, nulla Ambiorĭgi auxilia *misisse.*

II. *Grammatical questions, supplementary to the paper on Latin Grammar:*

1. State the construction of all italicized words in passages 1, 2, and 3.

2. Give the principal parts of all italicized words in passages 4, 5, and 6.

3. Quote from the text an example of indirect statement and re-write it so as to make it direct.

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HISTORY OF THE UNITED STATES.

JUNE, 1885.

1. Give the dates of the following events: Wolfe's capture of Quebec, settlement of Jamestown, Missouri Compromise, John Cabot's first voyage, and state who was president in 1805, 1815, 1825, and 1835.

2. Give an outline of the colonization of the Carolinas and of their early government.

3. Give an account of the Stamp Act Congress.

4. Describe the battles of the Brandywine and of Germantown.

5. When and under what circumstances was Florida obtained by the United States?

6. What was Clay's Omnibus Bill?

N. B.—The dates are to be given with every question.

HISTORY OF THE UNITED STATES.

SEPTEMBER, 1885.

1. Give the dates of the following events: Repeal of the Stamp Act, settlement of New Haven, Raleigh's first expedition, surrender of Mexico, and state who was president in 1803, 1813, 1823, 1833.

2. Give an account of the settlement of Massachusetts Bay.

3. Describe the battles of Trenton and Saratoga.

4. Give the principal events in the administration of Jackson.

5. State the circumstance of the annexation of Texas and its results.

6. What were the causes of the War of the Rebellion?

N. B.—The dates are to be given with every question.

GEOGRAPHY.

JUNE, 1885.

1. Bound the State of Georgia; give the names and situation of two cities in it.

2. Where does the Columbia River rise; what is its course, where does it empty, what States and Territories does it pass through or touch?

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3. What countries touch the Indian Ocean or its bays and gulfs?

4. Bound France; give the names and positions of three of its cities and two of its rivers.

5. Where is Afghanistan? bound it; name any city or place in it.

6. Where are the following cities: Bremen, Bombay, Tokio, Memphis, Valparaiso and Singapore?

GEOGRAPHY.

SEPTEMBER, 1885.

1. Bound the State of California; give the name and position of two cities in it.

2. Where does the Potomac River rise, what is its course, where does it empty, what States or Territories does it pass through or touch?

3. Name in their order, beginning south, the countries of South America, which touch the Atlantic Ocean or Caribbean Sea.

4. What islands constitute the Empire of Japan? describe their position; give the name and situation of one city in Japan.

5. Describe the Alps; what countries are by or near them; what rivers rise in them and where do these rivers run?

6. Where are the following cities: Alexandria, Liverpool, Portland, Hamburg, Herat, Valparaiso?

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APPENDIX II.

CATALOGUE OF GRADUATES: 1852–1884.

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CATALOGUE OF GRADUATES 1852–1884.

The following list includes the names of all those students in the Sheffield Scientific School who have been admitted by the President and Fellows of Yale College to the degree of Bachelor of Philosophy (Ph.B.), Doctor of Philosophy (Ph.D.), Civil Engineer (C.E.), or Dynamic Engineer (D.E.), from 1852, when degrees were first conferred on its students, to 1884 inclusive. The larger number have been undergraduate students in the school and have taken the degree of Ph.B. in course, in the year under which their names appear. With these are placed the names of graduates of other institutions who have in the same year received either the degree of Ph.B., or other higher degrees after pursuing studies, wholly or in part, in the Scientific School. The present occupation is given, so far as known, and on the right hand side of the page the present or permanent address. A star (*) prefixed to a name indicates death and a dagger (†) the class secretary. Persons who can furnish information appropriate to this catalogue are requested to write to the Secretary of the Sheffield Scientific School.

1852.

William Phipps Blake, A.M., Mill Rock, New Haven. Conn.
Mining Engineer, formerly Professor of Geology and Mining in the University of California.

William Henry Brewer, A.M., Ph.D., New Haven. Conn.
Professor of Agriculture, Sheffield Scientific School of Yale College.

George Jarvis Brush, A.M., New Haven, Conn.
Professor of Mineralogy and Director of the Sheffield Scientific School of Yale College.

William Jarvis Craw, Rowayton, Conn.
Oyster Grower.

William Arthur Shepard, A.M., Ashland. Va.
Professor of Natural Science and Chemistry, Randolph Macon College.

Ludwig Stadtmueller, New Haven, Conn.
Mineralogist and Dealer in Minerals.

Mason Cogswell Weld, Closter, Bergen Co., N. J.
Agriculturalist.

*George Washington Weyman, Ph.D., *1864.

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1853.

Charles Francis Chessman.	———
William Batcheler Cochran.	———
Daniel Farrand Henry, Patent Expert and Solicitor.	Detroit, Mich.
Benjamin Cutler Jillson, M.D., Ph.D., Professor of Zoology and Geology, Illinois Industrial University.	Champaign, Ill.
*William Henry McRuer.	*1858.
Gilbert Ezekiel Palen, M.D.	———
Albert Bowman Rogers. Civil Engineer, C. P. R. R. Survey, Mountain Division via. Winnipeg, Canada.	Winnipeg, Canada.

1854.

*Stephen Lyford Crosby.	*1875.
*John Antonio Duvillard.	*1865.
Raphael Espinosa.	———
Alonzo Tyler Mosman, Assistant on U. S. Coast and Geodetic Survey, Washington, D. C.	Beverly, Mass.
David Ball Parsons.	———
George Bowen Pierson.	———
Adrian Terry, A.B.	———

1855.

Frederick Hoyt Allen,	New Haven, Conn.
James Clarence McGregor,	Cincinnati, O.
Ira Moore.	———
Howell W. St. John, Actuary, Ætna Life Insurance Co.	Hartford, Conn.
Onofre Vengohechea,	Santa Martin, New Grenada.
George D. Walcott,	Detroit, Mich.
Thomas A. Wilcox,	Cedar Rapids, Iowa.

1856.

Armand Boisblanc,	New Orleans, La.
Joseph Hill Brinton, Farmer and Quarryman.	Thornburg, Chester Co., Pa.
Nathan Smith Bronson.	———
Gideon Horace Candee,	P. O. Box 21, Lowell, Mass.
Erastus Lyman DeForest, A.B., A.M.,	Watertown, Conn.
George Franklin Fuller,	Brighton, Mass.
George W. Lyle.	———

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Lewis Peck Morehouse, 4717 Kenwood Ave., Chicago, Ill.
Tax Department Illinois Central R. R. and Secretary of the Western Society of Engineers.

Isidore Plata, Bogota, New Grenada.

Henry Martyn Seely, M.D., A.M., Middlebury, Vt.
Professor of Chemistry, Middlebury College.

*Matthew Watson, *1864.

Lewis Williams, Cleveland, O.

1857.

Edward Curtis. ———

John King Gilbert, Concordia, La.

*Charles Harger, *1875.

Edmund Perlee Herrick, Athens, Pa.

Alexander Hamilton Kent, New Orleans, La.

*David Bigum Martin, *1869.

G. Harrison Meade, Little Rock, Ark.

Wm. Henry Pike, Mattituck, Suffolk Co., N. Y.
Farmer and Surveyor.

*Selden Silliman Richards, *1883.

1858.

*Demetrius Thomas Arosmena, *1880.

George Frederic Barker, M.D., 3909 Locust st., Philadelphia, Pa.
Professor of Physics, University of Pennsylvania.

John Marcus Blake, 1 York Square, New Haven, Conn.
Photographer on Wood.

Julius Gay, A.B., Farmington, Conn.
Treasurer Farmington Savings Bank.

*Henry Kelley Hodges, *1879.

Horace Kendall King, LL.B., Tully, Onondaga Co., N. Y.
Attorney at Law.

Charles Stewart Kittridge, C.E., M.D., Nashua, N. H.

Fidel Pombo, Bogota, New Grenada.

Alfred Perkins Rockwell, A.B., A.M., 3 Fairfield st., Boston, Mass.
Treasurer Great Falls Manufacturing Co.

*Edward Sackett, *1861.

*Orson Cowles Sparrow, A.B., M.D., *1877.

John Davenport Wheeler, New Haven, Conn.

1859.

Franklin Booth, M.D., East Windsor, Conn.

Henry Augustus DuBois, M.D.. San Rafael, Marin Co., Cal.

William Buck Dwight, A.B., Poughkeepsie, N. Y.
Professor of Natural History and Curator of the Museum, Vassar College.

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Alexis Wynns Harriott, A.B., Turk's Island, West Indies.

George Dallas Seely, Honesdale, Pa.
Assistant Examiner, Patent Office, Washington, D. C.

George Hazard Smith, New London, Conn.

Sutherland Douglas Twining, M.D., 306 West Indiana st., Chicago, Ill.

1860.

Clifford Coddington. ———

Alfred William Hearn, M.D. ———

Edwin Hutchinson, M.D., 224 Genesee st., Utica, N. Y.

*Edward Augustus Manice, A.B., *1877.

Joseph Addison Rogers, C.E. ———

Walter Scott Sheafer, Pottsville, Pa.
Mining Engineer.

1861.

Oscar Dana Allen, Ph.D., New Haven, Conn.
Professor of Chemistry and Metallurgy, Sheffield Scientific School of Yale College.

Hezekiah Bissell, American Society of Civil Engineers, New York City.
Master of Maintenance of Way, Boston and Maine R. R., Salem, Mass.

Charles W. Burrage, Portland, Oregon.
Civil Engineer.

José Filomenos Cifuentes, Copiapo, Chili.

Salomé Martinez, Matanzas, Cuba.

Gideon Emmett Moore, Ph.D., 69 Liberty st., New York City.
Chemist, New York City.

Carrington Howard Raymond. ———

Joshua Sands. ———

Eugene Schuyler, A.B., Ph.D., LL.D., 1024 17th st., Washington, D. C.

Arthur Williams Wright, A.B., Ph.D., New Haven, Conn.
Professor of Molecular Physics and Chemistry, Yale College.

1862.

Charles Henry Bunce, Hartford, Conn.
Civil Engineer and City Surveyor.

Juan Griñan, Santiago de Cuba, Cuba.

Clarence King, 18 Wall st., New York City.
Mining Engineer and late Director U. S. Geological Survey.

Daniel Smith Mead, Greenwich, Conn.
Attorney at Law and Judge of Probate Court.

Samuel Parsons, Jr., 76 Bible House, New York City.
Landscape Architect.

Hubert Cowles Ward, Los Angeles, Cal.
Civil Engineer.

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1863.

Josiah Willard Gibbs, A.B., Ph.D., Professor of Mathematical Physics, Yale College.	New Haven, Conn.
Watson Andrews Goodyear, Civil and Mining Engineer.	New Haven, Conn.
Arnold Hague, Geologist, U. S. Geological Survey.	Washington. D. C.
Landon Ketchum.	———
*Ignatio Megia,	*1865.

1864.

Charles Bill,	Springfield, Mass.
Robert Long Brownfield, Brownfield & Co., Commission Merchants.	103 N. Water st., Philadelphia. Pa.
Beverly Scott Burton, Ph.D.,	Munich, Bavaria.
Edwin Wallace Carpenter, Secretary Firemen's Fund Insurance Co.	Beverly. Cal.
Ellsworth Daggett, Mining Engineer.	Box 1088, Salt Lake City, Utah.
Frederick Farnsworth, M.D., Petroleum Refiner.	226 Walnut st., Philadelphia. Pa.
Albert Hiller Roffe, A. H. Roffe & Co., Subscription Agency.	11 Broomfield st., Boston, Mass.
Henry Dyer Tiffany,	Fox Homestead, Fox Corner, Station R, New York City.
Arthur Van Harlingen, M.D., Professor of Dermatology, Philadelphia Polyclinic.	129 S. 15th st., Philadelphia, Pa.

1865.

William Henry Glenny, Merchant.	Buffalo, N. Y.
Charles Holt, Henry Holt & Co., Publishers.	29 W. 23d st., New York City.
Francis Jedediah Leavens, Cotton Manufacturer.	Norwich, Conn.
Albert Parsons Massey, Mechanical Engineer.	1700 Wilson ave., Cleveland. O.
Alexander Smith Palmer,	Stonington, Conn.
Sanford Robinson, Civil Engineer.	320 Sansome st., San Francisco, Cal.
Harry Rogers, Banker, Tradesmen's National Bank.	Philadelphia. Pa.
*Theron Skeel, C.E.,	*1878.
James Bennett Stone, C.E., Washburn Manufacturing Co.	Worcester, Mass.
Frederick Folger Thomas, A.B., Superintendent United Verde Copper Mines.	Jerome via Prescott, Arizona.

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*Samuel Reading Throckmorton, A.B., A.M., *1880.

Martin Van Harlingen, 415 Wyoming st., West Philadelphia, Pa.
Principal Assistant Engineer, Pennsylvania R. R., Reading, Pa.

1866.

George Douglass Coit, Norwich, Conn.
Treasurer, Chelsea Savings Bank.

*Adrian John Ebell, M.D. *1877.

Charles Henry Gauss, Sedalia, Mo.

Wilford Linsly, 51 W. 10th st., New York City.
Artist.

Francis Englesby Loomis, A.B., Ph.D., Care of Prof. E. Loomis, New Haven, Ct.

*Alexander Ufford McAllister, *1874.

Charles Fraser McLean, A.B., Ph.D., New York City.
Attorney at Law.

John Jarvis Matthias, A.B., A.M., New Haven, Conn.
Shipping.

Charles Greene Rockwood, Jr., A.B., Ph.D., Princeton, N. J.
Professor of Mathematics, College of New Jersey.

1867.

Volney Giles Barbour, Burlington, Vt.
Professor of Civil Engineering, University of Vermont.

John Kennedy Beeson, Uniontown, Pa.

Alfred Caldwell, Wheeling, West Va.
Attorney General of West Virginia.

Samuel Hosmer Chittenden, C.E., Corcoran Building, Washington, D. C.
Chittenden Bros., Civil Engineers and Contractors.

*Lyman Stewart Ferry, *1869.

*Peter Houtz Grove, *1875.

Robert Michael Grove, Danville, Pa.
President, Grove, Grier & Co., Iron and Steel Boiler and Ship Plates.

Charles Henry Hubbard, Hartford City, Ind.
Spoke Manufacturer, Hartford City, Ind.

William Gilbert Mixter, New Haven, Conn.
Professor of Chemistry, Sheffield Scientific School of Yale College.

William Harmon Niles, Boston, Mass.
Professor of Geology, Massachusetts Institute of Technology.

William North Rice, A.B., Ph.D., Middletown, Conn.
Professor of Geology, Wesleyan University.

Charles Joseph Sheffield, Cleveland, Ohio.

Sidney Irving Smith, New Haven, Conn.
Professor of Comparative Anatomy, Sheffield Scientific School of Yale College.

Daniel Halsey Wells, C.E., Hartford, Conn.
Actuary and Assistant Secretary, Connecticut Mutual Life Insurance Co.

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Joseph Thompson Whittelsey, Box 833, New Haven, Conn.
Luther Hodges Wood, M.D., 429 Lawrence st., Denver, Col.

1868.

Wellington Miles Andrew, Orange, New Haven Co., Conn.
Farmer.

Leonard Strong Austin, Stratford, Conn.
Chemist, Germania Lead Works, Salt Lake City, Utah.

George Franklin Bailey, Rutland, Vt.
Locating Engineer, B. & M. R. R. R., Lincoln, Neb.

Samuel Atkins Barbour, Aspen, Col.
Superintendent, Spar Consolidated Mine.

Frederick Converse Beach, 361 Broadway, New York City.
Editor and President, N. Y. Amateur Photographic Society.

James DeTrafford Blackstone, Norwich, Conn.
Manufacturer.

†Eugene Stuart Bristol, 65 Elm st., New Haven, Conn.
Treasurer, U. S. Pin Co.

Albert Gardiner Clark, LL.B., 407 W. 6th st., Cincinnati, Ohio.
Attorney at Law.

Henry Marchant Dudley, Whitinsville, Mass.

Henry Turner Eddy, A.B., C.E., Ph.D., Cincinnati, Ohio.
Professor of Mathematics and Astronomy, University of Cincinnati.

Barton Darlington Evans, West Chester, Pa.
Editor.

Edward Forsyth Finney, City Hall, St. Louis, Mo.
Chief Clerk, Board of Public Improvements.

James Fowler, Duluth, Minn.
Lake Superior Elevator Co.

James Terry Gardiner, Albany, New York.
Director of New York State Survey.

Frank Morton Guthrie, 113 Vine st., Cincinnati, Ohio.
General Agent, Grand Rapids & Indiana R. R.

John Corey Hersey, U. S. Custom House, New York City.
Entry Clerk, Naval Office.

Rev. George Anson Jackson. ———

Joseph Scott McKell, Chillicothe, Ohio.
Importer of China, Glass and Queensware.

Charles Kinney Needham, C.E., Louisville, Ky.

Frederick George Noonan, Milwaukee, Wis.
Commission Merchant.

Lyman Bradley Parshall. Farman Village, N. Y.
Stock Raising, Kansas.

William Wallace Redfield. St. Paul, Minn.

Alexander Renick, Chillicothe, Ohio.
Vice-President, First National Bank.

*Joseph Perkins Rockwell, *1885.

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*Louis Bridge Stone, *1871.

Samuel Swift, M.D., Yonkers, N. Y.

Henry Shaler Williams. Ph.D., Ithaca, New York.
Professor of Paleontology, Cornell Univ., and Assistant Geologist U. S. Geol. Survey.

1869.

William Greene Abbot, Hartford, Conn.
Secretary of the Connecticut Mutual Life Insurance Co.

Wilbur Olin Atwater, A.B., Ph.D., Middletown, Conn.
Professor of Chemistry, Wesleyan University.

William Richardson Belknap, Louisville, Ky.
W. B. Belknap & Co.

Roman Augustus Bissell. Detroit, Mich.
Assistant Treasurer and Cashier of Riverside Storage Co.

Charles Augustus Brinley, 247 S. 16th st., Philadelphia, Pa.
Superintendent of Sugar Refinery.

Francis Dudley Buck, M.D., 43 W. 29th st., New York City.

Andrew Dwight Chidsey, Easton, Pa.
Manufacturer of Paints.

Clarence Marcellus Clarke, 501 Stanton Place, Washington, D. C.
Civil Engineer.

Frederick Smillie Curtis, Brookfield Centre, Fairfield Co., Conn.
Teacher.

Augustus Jay DuBois, C.E.. Ph.D., New Haven, Conn.
Professor of Civil Engineering, Sheffield Scientific School of Yale College.

Joseph Robinson Folsom, N. Y. Athletic Club, 6th ave. & 55th st., New York City.
Publisher, 751 Broadway, New York City.

Albert Banks Hill, C.E., City Hall, New Haven, Conn.
City Engineer, Department of Public Works.

Joseph Coerten Hornblower, Vernon Row, Washington, D. C.
Hornblower & Marshall, Architects.

Nelson Powell Hulst, A.B., Ph.D., 300 Knapp st., Milwaukee, Wis.
Mining Engineer.

*Edward Whiting Johnson, *1878.

Joseph Goodhue Kendall. ———

*Charles Byron Koon, *1885.

Houston Lowe, Dayton, Ohio.
Lowe Bros., Paints and Glass.

Edward Thomson Nelson, A.B., Ph.D., Delaware, Ohio.
Professor of Natural History, Wesleyan University.

Henry Hoyt Perry, Southport, Conn.
Insurance Agent.

George Henry Perkins, A.B., Ph.D., Burlington, Vt.
Professor of Natural History, University of Vermont.

Charles Henrique Pope, 515 N. Main st., St. Louis, Mo.
Deere, Mansur & Co.

Joseph John Skinner, C.E., Ph.D., Ithaca, N. Y.

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Robert Schuyler Van Rensselaer, Uniontown, Fayette Co., Pa.
Civil Engineer.

Charles Alva Weed, 83 Court st., Binghamton, N. Y.
Wholesale Manufacturer of Clothing.

William Robert White, Philadelphia, Pa.

Horace Franklin Whitman, 12th & Market sts., Philadelphia, Pa.
Stephen Whitman & Son.

Willard Wendell Wight, Natick, Mass.
Civil Engineer.

†Frederick Everett Willits, Glen Cove, Queens Co., L. I.
Farmer.

1870.

James Whitin Abbott, A.B., Lake City, Col.
Mining Engineer.

Henry Moore Bailey, Louisville, Ky

Charles Thurston Ballard, Louisville, Ky.

Thomas Gray Bennett, New Haven, Conn.
Vice-President of Winchester Repeating Arms Co.

Townshend Stith Brandegee, Berlin, Conn.
Civil Engineer.

Daniel Seymour Brinsmade, Birmingham, Conn.
Engineer Ousatonic Water Co.

Charles Peter Brooks, Salt Lake City, Utah.
Civil Engineer and U. S. Deputy Mineral Surveyor.

Thomas Elwood Calvert, Newtown, Pa.

*Frederick Hosea Churchill, LL.B., *1881.

Dorr Clarke, Green Bay, Wis.
Stock Raising, Spearfish, Dakotah.

Alfred Ronald Conkling, LL.B., 27 E. 10th st., New York City.
Attorney at Law.

Justus Herbert Grant, Rochester, New York.
Civil Engineer, Ellsworth Luther & Co.

Charles Sheldon Hastings, Ph.D., New Haven, Conn.
Professor of Physics, Sheffield Scientific School of Yale College.

William Alfred Hinds, Community, Madison Co., N. Y.
Secretary of Oneida Community, limited.

Edward Van Buren Hoes, Chicago, Ill.
Union National Bank.

William Rufus Hopson, Bridgeport, Conn.
Wholesale Grocer.

Henry Correll Humphrey, 36 E. 62d st., New York City.
Chemist, 34 Dey st., New York City.

Augustus Washington Littleton, Quincy, Ill.
Superintendent of Quincy Gas Co.

*Francis Asbury Lowe, *1883.

†William Dennis Marks, C.E., Philadelphia, Pa.
Professor of Mechanical Engineering, University of Pennsylvania.

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Arthur Woods Rice, New Britain, Conn.
City Engineer and President of Water Board.

George Douglass Roseberry, Pottsville, Pa.

Alfred Stanton, Sligo, Md.

Clarence Augustus Warren, 611 W. Main st., Louisville, Ky.
Merchant.

John George Watson, Ayr, Canada.
Superintendent Watson Manufacturing Co., Agricultural Implements.

1871.

Horace Andrews, C.E., State Survey Office, Albany, N. Y.
Assistant, New York State Survey.

Edwin Faxon Bacon, Newark, N. Y.

Luther White Burt, 330 Main st., Hartford, Conn.
Civil Engineer.

George Benjamin Chittenden, C.E., Corcoran Building, Washington, D. C.
Chittenden Bros., Engineers and Contractors.

Russell Wheeler Davenport, Nicetown, Philadelphia, Pa.
Superintendent of Midvale Steel Co.

William Cecil Durand. Milford. Conn.
Farming.

Charles Hascall Dwinelle, Berkeley, Alameda Co, Cal.
Lecturer on Practical Agriculture, University of California.

Charles Addison Ferry, City Hall, New Haven, Conn.
First Assistant City Engineer.

Charles Henry Greene, Cincinnati, Ohio.
President of the Standard Nail and Iron Co.

*Charles Woodford Griswold, *1878.

Bernard James Harrington, A.B., Ph.D., Montreal, Canada.
Greenshields Professor of Chemistry and Mineralogy, McGill University.

George Macculloch Keasbey, LL.B., Newark, N. J.
Assistant U. S. Attorney, District of N. J.

Joseph Frederick Klein, D.E., Bethlehem, Pa.
Professor of Mechanical Engineering, Lehigh University.

George Granville Lobdell, Wilmington, Del.
Lobdell Car Wheel Co.

Thomas William Mather, D.E., New Haven, Conn.
Instructor in Mechanical Engineering, Sheffield Scientific School of Yale College.

Mansfield Merriman, C.E., Ph.D., Bethlehem, Pa.
Professor of Civil Engineering, Lehigh University, Acting Assistant U. S. Coast and Geodetic Survey.

Alfred Lewis Moore, Fond du Lac, Wis.
Vice-President of La Belle Wagon Works.

*Daniel Hobart Pierpont, *1874.

*Ferdinand Eugene Powell, *1872.

John Franklin Quigley, Niagara Falls, N. Y.
Manufacturer of Wood Pulp.

Frederick Lockwood Sanford, New Haven, Conn.

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†Henry Bradford Sargent, New Haven, Conn.
Sargent & Co., Manufacturers of Hardware.

Edward Clinton Terry, Hartford, Conn.
Manufacturer.

Henry Degen Ziegler, 218 S. Front st., Philadelphia, Pa.
Hannis Distilling Co.

1872.

Jacob Jackson Abbott, C.E., Lake City, Huisdale Co., Col.
Civil and Mining Engineer.

James Peter Bogart, New Haven, Conn.
Engineer, Connecticut Shell Fisheries Commission.

Wheeler DeForest Edwards, A.B., LL.B. ——

Joseph Ridgway Gawthrop, Kennett Square. Pa.
Manufacturer of Fertilizers.

William Saunders Green, 200 Main st., Cincinnati, Ohio.
Treasurer of the Standard Nail and Iron Co.

*George Wesson Hawes, Ph.D., *1882.

Daniel Webster Hering, C.E., Johnsville, Westminster, Md.
Professor of Mathematics, Western Medical College.

Charles Lewis Johnson, New Haven, Conn.
Secretary of the Candee Rubber Co.

Cassius William Kelley, A.B., 18 City Hall, New Haven, Conn.
Assistant City Engineer.

Samuel Trevor Knapp, Jr., Box 3735, New York City.
Banker and Broker, 43 Exchange Place.

Harrison Wheeler Lindsley, C.E., 15 Elm st., New Haven.
Architect.

Frank Oscar Maxson, C.E., 647 E. Capitol st., Washington. D. C.
Civil Engineer, U. S. Navy, U. S. Naval Station, Port Royal, S. C.

Robert Douglass Milholland Maxwell, LL.B., 615 Walnut st., Phila., Pa.
Attorney at Law.

George Noyes Miller. ——

Charles Theodore Morse, LL.B., 851 Chapel st., New Haven, Conn.
Attorney at Law.

*Thomas Perkins Nevins, *1875.

Theophil Mitchell Prudden, M.D., 114 E. 26th st., New York City.
Director of the Physiological and Pathological Laboratory, College of Physicians and Surgeons.

Thomas Hubbard Russell, M.D., 137 Elm st., New Haven, Conn.
Professor of Therapeutics and Materia Medica, Yale Medical School.

†Rev. Charles Austin Tibbals, 345 State st., Brooklyn, N. Y.

*Daniel Wardwell Wardwell. *1878

Frederick Floyd Weld, Waterbury, Conn.
City Engineer.

Richard Chapman Weldon, Ph.D. ——

William Brenton Welling, 18 Wall st., New York City.
Broker.

Thomas Wallace Wright, A.M., C.E., Galt, Canada.

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1873.

John Winthrop Auchincloss, 4 W. 49th st., New York City.
Merchant, Auchincloss Bros.

Edgar Henry Summerfield Bailey, Ph.D., Lawrence, Kansas.
Professor of Chemistry, University of Kansas.

Alva Weed Brown, Box 2644, New York City.
Insurance, 145 Broadway.

Moses Bulkley, 74 John st., New York City.
Bulkley, Dunton & Co.

Fillmore Cogswell, Marbledale, Conn.

William Righter Comings, 128 Queen Victoria st., London, England.
Engineers' and Patentees' Agents.

William Allen Cowles, Patent Office, Washington, D. C.

*Charles Adams Cragin, *1878.

Neville B. Craig, A.B. Pittsburgh, Pa.

Robert J. Currey, Dixon, Solano Co., Cal.
Wheat and Stock raising.

Francis Urquhart Downing, A.B., D.E., Columbus, Ga.
Mechanical Engineer and Draughtsman.

Harry Taylor Gause, Wilmington, Del.
Vice-President & Secretary of the Harlan & Hollingsworth Co., Steamship & Car Builders.

Edward Julius Hall, 637 N. Broad st., Elizabeth, N. J.
President of the Perth Amboy Terra Cotta Co., 80 Astor House, New York.

Henry Sheaff Hoyt, LL.B., Staatsburgh, Dutchess Co., N. Y.
Counselor-at-Law, 20 N. Washington sq., New York City.

Robert Jaffray, Jr., 7 W. 46th st., New York City.
W. R. Grace & Co., 142 Pearl st.

William Hampton Jenks, D.E. Brockville, Jefferson Co., Pa.
Iron Founder and Machinist.

Charles Rockwell Lanman, A.B. Ph.D., Cambridge, Mass.
Professor of Sanskrit, Harvard University.

George Christopher Moore, New Haven, Conn.
Draughtsman, F. C. & A. E. Rowland.

William Josiah Parks, Brooklyn, N. Y.
W. M. Parks & Son, 20 New st., New York City.

Andrew Wheeler Phillips, A.M., Ph.D., New Haven, Conn.
Professor of Mathematics, Yale College.

*Benjamin Pomeroy, *1875.

Samuel Rockwell, 120 Broadway, New York City.
Civil Engineer, St. Paul, Minn.

Amory Edwards Rowland, New Haven, Conn.
Manufacturer of Machinery.

Edgar Camp Savage, Meriden, Conn.
Meriden Britannia Co.

William Lucien Scaife, C.E., 39 Water st., Pittsburg, Pa.
Chairman of Scaife Foundry and Machine Co., Limited.

Alfred Lewis Sellers, 32d and Walnut sts., Philadelphia, Pa.

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Charles Thompson Smith, 121 W. 39th st., New York City.
Treasurer of the Geo. W. Allen Co., Limited.

*Louis Rodney Taylor, *1882.

Edward Allen Wilson, A.B. ———

Henry Goodrich Wolcott, LL.B., Fishkill-on-Hudson, N. Y.

1874.

Henry Prentiss Armsby, Ph.D., Madison, Wis.
Professor of Agricultural Chemistry, University of Wisconsin.

Nathan Edward Beckwith, New Haven, Conn.
Farmer, San Jose, Cal.

Jacob Alexander Bezjian, Aintab, Syria.
Professor of Physical Science, Central Turkey College.

Charles Cook Brewster, Buffalo, N. Y.
Northrop, Mathews & Co., Publishers, 179 Washington st.

Edward Brush, 116 Pearl st., N. Y.
Empire Refining Co.

Arthur Bucklin Claflin, 73 High st., Boston, Mass.
Merchant, Newtonville, Mass.

Charles Benjamin Dudley, A.B., Ph.D., Altoona, Pa.
Chemist to the Pennsylvania R. R. Co., Altoona, Pa.

Augustus Hjalmar Edgren, Ph.D., Sweden.
Professor of Sanscrit, University of Lund.

Franklin Edwards, 11 Wall st., N. Y.
Broker, Soutter & Co.

Charles Howard Fitch, D.E., Macon, Ga.
Mechanical Engineering, New Haven, Conn.

Edwin Horace Forbes, Holyoke, Mass.
Principal of the Holyoke High School.

*LeRoy Gale, M.D., *1883.

Jacob Houtz Grove, Danville, Pa.
Manufacturer of Pig Iron, Fredericksburg, Pa.

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1875.

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1881.

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1882.

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1883.

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1884.

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James Henry Warner, Portsmouth, O.

Elmore Abram Willets, Belmont, Alleghany Co., N. Y.
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The Annual Report will be sent regularly to all graduates who may express the desire to receive it, and who furnish their addresses for the purpose. It is desirable that any change of address should be communicated by the first of January of each year.

For Circulars and other information, address

PROFESSOR G. J. BRUSH,

NEW HAVEN, CONN.

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TWENTY-FIRST ANNUAL REPORT

OF THE

SHEFFIELD SCIENTIFIC SCHOOL

OF

YALE UNIVERSITY,

1886-7.

PRINTED BY ORDER OF THE GENERAL ASSEMBLY.

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State Senators.

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HON. JOSEPH W. ALSOP, Middletown.
HON. STILES T. STANTON, New London.

Secretary of State Board of Education.

CHARLES D. HINE.

Secretary and Treasurer of the School.

GEORGE J. BRUSH.

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REPORT

OF THE

STATE BOARD OF VISITORS.

To the General Assembly of the State of Connecticut:

We, the State Board of Visitors, herewith present to your honorable body the statement of the Governing Board of the Sheffield Scientific School for 1886.

We would report that we have attended to the duties devolving upon us, and have found every department of the School in a healthy and flourishing condition.

The fund derived from the Congressional Land Grant for the benefit of Agriculture and the Mechanic Arts is invested in accordance with the law. The actual revenue derived from that source in 1886 was $6,811.16.

We would respectfully call careful attention to that part of the statement entitled "Relations between the State of Connecticut and the Sheffield Scientific School"— because we believe that heretofore those relations have been but very imperfectly understood, and the good resulting but very slightly appreciated.

In conclusion we do not hesitate to say that the good work accomplished and being continually carried on by the Sheffield Scientific School renders it a most fitting monument to the memory of the distinguished citizen whose name it bears and an honor to our State.

HENRY B. HARRISON,
Chairman.

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ANNUAL STATEMENT

OF THE

GOVERNING BOARD.

In presenting their twenty-first Annual Report of the Sheffield Scientific School, the Governing Board can do little more than repeat the remarks of the last Report in regard to the prosperity of the institution, so far at least as numbers are concerned. It has never had so many students in attendance; it has never had so large an entering class. The resources of the school are taxed to the utmost to furnish the proper facilities for the increasing numbers; and it is obvious that at no distant day further accommodations in lecture rooms, recitation rooms and laboratories must be provided in order to carry on the work of instruction properly, as well as to maintain the position which the institution has won.

Relations between the State of Connecticut and the Scientific School.

Previous to the last session of the Legislature a series of newspaper attacks were made upon the school in connection with the Congressional Land Grant of 1862. These appeared mainly in agricultural journals outside of this State, but they had sufficient circulation and influence in it to lead to the examination by a joint Committee of the Legislature of the conditions under which the revenue from this source had been turned over to this department of Yale College. The Committee in their report gave the history of the grant, so far as it was exhibited in legislation; but as they found in existence a perpetual contract between the State and Yale College, they contented themselves with presenting facts without making any recommendations. Their report, how-

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ever, is necessarily far from containing all the facts. As erroneous assertions on the subject therefore still continue to be widely circulated and received as true, the Governing Board are not satisfied with resting merely upon their legal rights. They believe that the misrepresentations of which the school has been made the subject, have arisen, so far at least as this State is concerned, not from any ill will felt toward the institution, but from ignorance of the real state of the case. They accordingly wish to put before the Board of Visitors, and through it before the Legislature, a fuller account of the transactions connected with the Congressional grant of 1862, the action that has in consequence been taken by the school, and the results that have followed this action.

It will be first necessary to state the charges. It is said that the land grant referred to was made by Congress for the sake of promoting agriculture; that for this object the income derived from it was ordered by the State to be paid over to this department of Yale College: that the amount turned over has in the course of twenty-four years, reached the neighborhood of $180,000; and that there have been graduated some seven or eight students from the agricultural department of this school. The inference is then drawn that the education of these is all that the State has received for its expenditure, and that in consequence each graduate has practically cost the State about $25,000. The reason for this condition of things is further given as being largely due to the high standard of requirement for admission which prevents men from attempting to come, who would otherwise have been glad to pursue the course laid out; and that as a result the school is not honestly carrying out the object which Congress had in view in making the land grant. These are certainly grave charges. Are they true? We trust to make it clear to every person that they are the exact reverse of the truth and spring entirely from ignorance both of what was contemplated by Congress and what has been accomplished by the school.

It will be first necessary to take notice of a widely prevalent misconception in regard to the character and intent of the act passed by Congress in 1862. It is constantly spoken of as if its only design had been the promotion of agriculture, and in fact it is often called popular speech in the Agricultural College Bill. The language of the act bears no such interpretation. It puts

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the mechanic arts upon a full equality with agriculture. It declares that "the leading object" of the institution shall be "to teach such branches of learning as are related to agriculture and the mechanic arts." It goes farther than this. It definitely states that other scientific or classical studies are not to be excluded. And the section of the statute laying down the nature of the instruction to be given closes with the expression that it was enacted in order to promote not merely the practical but also the liberal education of the industrial classes. It was not to teach the details of agricultural practice, or the processes employed in manufactures that Congress established these institutions. Things of this kind can be learned far better on the farm and in the workshop. It was not to found manual labor schools. It was not even to furnish the instruction imparted by a purely technical school, valuable as such instruction assuredly is. It was designed, as the act itself said expressly, "to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life."

The sum realized by Connecticut from the sale of its scrip was $135,000. It was impossible with any such amount as this to establish an institution such as was contemplated by the act. At the very outset it would have been necessary to have furnished instruction in agricultural chemistry, in mathematics, and in engineering; and to secure properly qualified teachers in those other departments an outlay of $150,000 would have been required at once, to say nothing of buildings, laboratories and apparatus. States which received from the general government a far larger gift than Connecticut, did not, in most cases, certainly, think it sufficient. The scrip received by New York was more than five times that obtained by this State, and it was so managed as to yield a vastly larger sum in proportion. Yet New York did not finally make a grant of what she had received, until one of her citizens supplemented the gift of the national government by a personal gift of $500,000 as a foundation for the college to be created. If Connecticut did not care to enter into the expense involved in establishing a new institution, her only resource was to convey to some institution already existing the amount obtained from the sale of the land scrip. The latter course was decided upon. The Sheffield Scientific School was selected as the recipient of the gift. It had already a full corps of instructors and a full equipment in the very subjects required to be taught.

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It had the means of furnishing at once both the practical and the liberal education which the act of Congress demanded, and that without putting the State to the slightest additional expense.

Accordingly the Legislature passed in 1863 an act devoting to this department of Yale College the interest of the fund received from the Congressional land grant. It directed a contract to be made with Yale College before any portion was paid over; and in accordance with this provision a contract was made the same year with the Corporation of the College, in which the requirements of Congress and of the State Legislature were carefully embodied. One of the latter is of special importance in connection with this subject. Gratuitous education was to be furnished by the school to a certain number of students from the State of Connecticut. "The number of pupils to be so received gratuitously into said school," were the words of the act, "shall be, in each year, such a number as would expend a sum equal to one-half of the said interest for the same year in paying for their instruction in said school if they were required to pay for it at the regular rates charged to other pupils of said school for the same year. Said pupils so nominated and received shall be citizens of this State, and shall be admitted into said school upon the same terms and subject to the same rules and discipline which shall apply to all other pupils of said school, with the single exception that they shall not be required to pay anything for their instruction."

The contract having been made, the Scientific School set out at once to fulfill its part. It was already equipped with the necessary machinery and instructors to carry out the intent of the Congressional act. It had, in particular, a professor of Agricultural Chemistry; it had a professor of Engineering; it had numerous other professors in other departments of science. But its Governing Board had no desire to content themselves with any mere formal compliance with what could be demanded legally. They set to work to extend their accommodations, and proceeded at a cost of $60,000 to refit and enlarge their building and laboratories. They went further and created a special chair of Agriculture. To fill this, they sought for a man who should be fitted by practical knowledge and scientific training to be of the best service to the agricultural interests of the State. They found such a one in Professor Brewer, who was at that time connected with the California Geological Survey. He accepted the posi-

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tion offered and came on at once. Having made all these arrangements, which involved an investment of much more than one hundred thousand dollars, they proceeded to comply with the further requirements of the supplementary law which directed them to give notice of the gratuitous instruction afforded to a certain proportion of students coming from this State.

The school had certainly fulfilled its part of the contract. It had done much more than the law required or the State prescribed. If not a single student had presented himself in the department of Agriculture or the Mechanic Arts, no fault could be laid to its charge. It had provided the apparatus for instruction; young men must decide for themselves whether or not they would make use of the opportunities for the special education offered. Neither the school nor the State could compel students to come. Neither it nor the State could compel them to study subjects relating to agriculture after they did come. Neither it nor the State could compel them, if they did study agriculture, to pursue it as an occupation after they had graduated. And it is certainly true that for the three or four years after the grant was made, the applicants for gratuitous instruction here given did not reach the full number to which the State was entitled. The thing was new; the advantages afforded though advertised, as the law directed, were not widely known or understood. Neither in the studies related to agriculture or the mechanic arts was there at first any wide-spread demand apparently for the instruction furnished. Nor need it be denied that in the case of the former this indifference has largely continued. The same causes which have operated to prevent large numbers from pursuing the scientific study of agriculture in every other State have operated here also. Every careful observer sees what they are; they do not need to be discussed in this place. They will become less and less influential with the progress of time; but it will be long before they cease to exert great influence. The result has most certainly been that the school has had but few students who cared to devote themselves to the special study of the science of agriculture.

But Connecticut is likewise a great manufacturing State. It was not long before the advantages here presented came to the knowledge of the young men who wished to acquire scientific training in subjects related to the mechanic arts. The number of applicants from this source increased rapidly, and speedily took up every free scholarship to which the State was entitled. It is

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under the circumstances not amiss to add that free tuition was granted in many cases beyond the number to which the State was entitled. In this matter the Governing Board can feel that they have pursued no ungenerous policy; and the official records will show that their action has always evinced a desire to further, even at their own expense, the objects contemplated by the Congressional act. From the minutes of the State Appointing Board for 1870, it appears that it was reported to that body that the number of scholarships not as yet taken up for the coming year would be seven, and that the number of applicants for these was eleven; but the Appointing Board was informed that the School would receive all competent applicants even if in excess of the legal number. The eleven were accordingly appointed. The policy thus indicated has from that time prevailed, so far as the limited resources at the command of the Governing Board would permit. There has scarcely been a single year since in which gratuitous instruction has not been furnished by the School to appointees from the State beyond the number to which the State was entitled.

The increasing demand for instruction in the subjects relating to mechanic arts, in fact, soon rendered it necessary for the Scientific School to make a further investment of capital. In 1870 therefore, the professorship of Engineering was divided, and a new professorship of Mechanical Engineering was created. This, moreover, involved a large additional outlay in the purchase of apparatus, and the further equipment essential for prosecuting the studies of this course, which bears so directly upon the manufacturing interests of this State. The School was hardly in a pecuniary condition at the time to venture upon this extension: but the demand for this kind of instruction was becoming so great that the Governing Board felt it incumbent to risk the still further expenditure involved in carrying out the objects aimed at by Congress in the act of 1862.

There are two other points also that it is important to mention in connection with this part of the subject. One is that the benefits of the institution to the citizens of this State have not been confined to those who have received their education here without being obliged to pay for it. The reputation of the School has gone over all the land, and students have come to it from the most distant parts of the country. Still the most noteworthy thing in its history is the regularly increasing number of pupils

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from Connecticut. A glance at the table on page 16 will show that on the roll of students thirty States or countries are represented; but it will also show that much more than one third of the number come from this State alone. This is a proportion that has been growing with the growth of the School, and bears of itself ample witness to the success with which it has met the demand for the special practical education contemplated by the act of Congress.

The second point is that the students for whose instruction the State pays receive here advantages for which the State does not pay. The whole income of the Scientific School amounts to about sixty-thousand dollars a year. Of this about fifty-five thousand dollars are spent wholly on instruction, leaving but five thousand for the expenses of administration, heating and lighting and charge of buildings, and other incidental matters. To this sixty-thousand the State contributes about one-ninth, and half of what it contributes is at once repaid in free tuition. Yet upon every student whom it sends, the advantages which the expenditure of sixty-thousand a year brings with it, are conferred fully. Besides this, by the connection of the School with Yale College, such students have free access to all the museums, libraries, and collections of all sorts belonging to the University which have been gathered by the labor or given by the liberality of past generations.

Have these opportunities actually been improved? Have they been neglected owing to the indifference of the people of this State, or has the enjoyment of them been thwarted by the restrictions or the requirements imposed by the Governing Board? How many are the students of Connecticut who have received free instruction in this School in consequence of the receipt by it of the interest from the sale of the land scrip? Are they the dozen more or less that have been so frequently mentioned by the press, as the entire number who have been educated under the provisions of the Congressional Act of 1862? The records of the Appointing Board tell quite a different story. From these it appears that the whole number of State students who have been in the School for a longer or shorter period amounts to two hundred and forty-one. Of these one hundred and fifty-two have gone regularly through the course and received the degree of Bachelor of Philosophy. Their names are upon the rolls of the Appointing Board, and are accessible to any persons properly authorized by

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the State Government or Legislature. Without a direct order from the latter body the authorities of the School were unwilling the last year to give up their names to be printed: and with this view the Committee of the Legislature, it is understood, fully coincided. It has been the policy of the institution to keep this list secret. The student who receives gratuitous instruction may disclose the fact if he wishes: but no one else is authorized to do so, and hardly any one else has the power to do so. The Director of the School—who by virtue of his office is a member of the Appointing Board—knows who these men are; but he is the only instructor that does. Many of these persons thus educated are filling responsible positions, either in this State or in the country at large. It does not seem just that their names should be published as beneficiaries without their own consent.

It is clear from this statement that the assertions so widely circulated in regard to the number of students who have been educated at the expense of the State have not the slightest foundation in fact. Equally baseless is the theory set up to explain the reason for the pretended facts. It has been said that the requirements for admission were so high that capable intelligent farmers' boys were deterred from seeking to gain admission. Such a statement casts an unmerited slur upon the agricultural population of the State. It represents the students coming from that portion of the inhabitants as being unable or indisposed to reach a level attained with no special difficulty by students coming from every other class. Young men who are intending to pursue the study of the mechanic arts have not found these requirements too difficult. In several instances students of the School have come direct from the workshop. They have had to spend their days in labor, and to limit their time of preparation to the hours of the evening. If with such drawbacks they can succeed in fitting themselves, it would be a gross imputation upon the character of the young men coming from the farming class, to maintain that they with far ampler leisure could not make easily the desired preparation. Nor is there any question as to the actual fact. They have made easily the necessary preparation. A large number of the students of the Scientific School are and have been the sons of Connecticut farmers. Many of them are graduates of the institution, and are occupying positions of trust and profit, and would very certainly be found opposed to lowering the standard of the education which they

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have received. Nor is there any necessity for such a procedure even from the point of view of those who ask for lower requirements of admission for the sake of such as have neither the time nor the means to go through the regular courses. There has never been a time in the history of the Scientific School when students could not be admitted to any course, such as that of agriculture, without examination. Special students there have always been and are now; and special students enter directly upon their studies without passing the regular examination.

These are the facts in regard to the action taken severally by the State and the School, and the results that have followed from them. They can all be easily substantiated to the minutest particular. They are certainly far from sustaining the view that in the contract which the State entered into with Yale College, the former made a losing bargain. Connecticut has never made the slightest appropriation from her own funds for the benefit of the Scientific School. No man in her limits has ever been obliged to pay a dollar of tax for the support of the institution which is technically the State College founded under the land grant of 1862. On the other hand the Scientific School itself has made a direct outlay of more than two hundred thousand dollars to carry out, so far as lay in its power, the intent of the act passed by Congress. It has been so successful in this object, that whenever the wisdom of the national land grant has been doubted or denied, this institution has been pointed out everywhere as a striking justification of the intelligence and judgment displayed in the policy then adopted. The Governing Board have no disposition to deny the advantage which the School—especially in the beginning, when it was comparatively feeble—received from the action of the State making it the recipient of the income from the Congressional fund. They have been confident that the contract between the two has been to the interests of both. They are equally confident, however, that if a balance of benefits is to be struck, it will be found that the State has received under the terms of the contract it entered into with Yale College far more than it has ever conferred. And since the management of the School has been subjected to criticism, it may not be improper to make two or three statements, which under other circumstances it would be perhaps in better taste to leave unsaid. For years the School gave up to the State a share of its buildings as quarters for the Agricultural Experiment Station, without asking or receiving

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compensation: and had not its increasing numbers cramped it for space to carry on its own work, it would never have sought to resume what it had willingly furnished. For years it has continued to give gratuitous instruction to students from Connecticut beyond the number required by the law; and had it had the means at its disposal, would have given far more than it has done. The proportion to which the State is now entitled, with the diminished amount of interest now paid, is exactly twenty-two and a half; but the Scientific School bears to-day twenty-five on its rolls, as State students. In past years the proportion between the number for whom free instruction could be demanded and the number to whom it has actually been given has been greater. It is perhaps unnecessary to add in conclusion that the Governing Board will be glad to have the fullest and closest scrutiny made by properly constituted authorities of the relations which exist between this department of Yale College and the State of Connecticut, and of the manner in which the interest of the Congressional act of 1862 has been carried out by the former.

Zoological Collections.

A. E. Verrill, Curator; K. J. Bush and C. E. Bush, Assistants.

The most important additions to the collections, as during several years past, have been due to the coöperation of the curator with the U. S. Fish Commission in the exploration of the deep sea off our coast. During the past season the dredgings were carried on in the region of the Gulf Stream, from off Cape Hatteras to Newfoundland, and from shallow water to 2620 fathoms, by means of the steamer Albatross, Lieut. Z. L. Tanner commanding. The Flemish Cap, off Newfoundland, was also explored. The party was organized nearly as in the two previous years. Large collections were made, and the greater part of the Invertebrata were sent here for identification and description, as in previous years.

The curator has printed during the year in the Annual Report of the Fish Commission a general account of the deep sea fauna off our coast, with numerous plates.

Professor S. I. Smith has published in the Annual Report of the U. S. Fish Commission, for 1885, a detailed report on the Decapod Crustacea dredged by the "Albatross" in 1884. It is illustrated by twenty plates.

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Misses K. J. Bush and C. E. Bush have continued the work of cataloguing and labeling the collections dredged by the Fish Commission, besides attending to the usual work of assistants in the museum. Miss K. J. Bush has also prepared for publication a report on the shells dredged by the Coast Survey Steamer "Blake," in deep water off our coast, in 1880.

In addition to the collections dredged by the U. S. Fish Commission the following have been received:

H. C. Rowe & Co. An eelpout from off New Haven.

Hill Brothers. A *Pholas* from Savin Rock, West Haven, Conn.

Geo. E. Verrill. Birds, mammals, fishes, reptiles and shells from near Malabar, Indian River, Fla.; and birds from New Haven. Purchased.

H. T. Woodman. Corals, shells and *Echini* from the East Indies and Bahama Islands. Purchased.

A. Hermann. Albino muskrat (*Fiber zibethicus*) from North Haven, Conn. Purchased.

Professor O. C. Marsh. Annelids and Crustaceans from Central America.

Dr. George Bauer, Peabody Museum. Two specimens of *Necturus* from Ohio.

C. H. Vedder. A salamander from Branford, Conn.

W. B. Fenn. A brown pelican from California.

George Comer. Skins of two albatrosses (*Diomedea exulans*) and eggs from Desolation Island; nine eggs of various sea birds from South Georgia Island. Purchased.

Henry Hotchkiss Townshend and Harry Parmelee. A very large snapping turtle from Lake Saltonstall, East Haven, Conn.

Capt. Chas. Harvey Townshend. Specimens of oysters, including two very large ones, from near New Haven; sword fish eyes from Portland, Me.

Ernest F. Cox. Skeletons of a crow and fan-tail pigeon. Purchased.

Mr. Chas. Earle. Specimens of coral (*Madracis decactis*) from Bermuda.

John Allen. A rare sea-anemone (*Paractis rapiformis*) from Cornfield Point at Saybrook, Conn.

A. H. Verrill. Mammals and reptiles in alcohol from White Mts., N. H.; woodchuck, mounted, and two snipes, New Haven.

U. S. Fish Commission. Rare sea bird (Cory's spearwater, *Puffinus borealis*) from Vineyard Sound, Mass.

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——— Andrus. A very large and remarkable jelly fish, hitherto undescribed (*Nectopilema* Fewkes, gen. nov.), taken in New Haven harbor.

States Represented in the School.

The following table shows the States and Countries from which come the students whose names appear on the catalogue during the current year, and the proportion of numbers that belong to each.

	Graduates.	Seniors.	Juniors.	Freshmen.	Special.	Total.
1. California	--	--	2	6	--	8
2. Colorado	--	1	3	--	--	4
3. Connecticut	10	24	36	34	3	107
4. Dakota	--	--	1	--	--	1
5. District of Columbia	--	--	--	--	1	1
6. Illinois	1	5	8	6	--	20
7. Indiana	--	3	--	2	--	5
8. Kentucky	--	--	1	2	--	3
9. Louisiana	--	--	1	1	--	2
10. Maine	--	--	1	2	--	3
11. Massachusetts	--	2	1	2	1	6
12. Michigan	--	--	2	--	--	2
13. Minnesota	1	1	--	1	--	3
14. Missouri	2	--	--	1	--	3
15. Nebraska	1	1	1	--	--	3
16. New Hampshire	--	--	--	1	--	1
17. New Jersey	2	--	--	4	1	7
18. New York	2	13	17	16	--	48
19. Ohio	2	3	3	10	--	18
20. Pennsylvania	1	3	4	10	--	18
21. Rhode Island	--	--	4	1	--	5
22. Tennessee	--	--	--	1	--	1
23. Texas	--	1	--	--	--	1
24. West Virginia	--	--	--	1	--	1
25. Cuba	--	--	--	1	--	1
26. Japan	--	--	1	--	--	1
27. Mexico	1	--	--	--	--	1
28. Sandwich Islands	--	--	2	1	--	3
29. Saxony, Germany	--	1	--	--	--	1
30. Turkey in Asia	--	--	--	1	--	1
Total	23	58	88	104	6	279

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Public Lectures.

The annual course of lectures to mechanics and others was given during the second term of the Academic year, 1884–85. The lectures and their subjects are indicated in the annexed programme:

I.	Tuesday, Feb.	23.—The Sandwich Islands.	Prof. Wayland.
II.	Friday. "	26.—The Elizabethan Drama in its Relations to Society.	Prof. Lounsbury.
III.	Tuesday, Mar.	2.—The English Race-Horse.	Prof. Brewer.
IV.	Friday, "	5.—Leaves from the Diary of a Young Man in Moscow in 1849,	Hon. C. M. Ingersoll.
V.	Tuesday, "	9.—Penalty vs. Prevention.	Mr. A. T. Hadley.
VI.	Friday. "	12.—Oranges.	Prof. Eaton.
VII.	Tuesday, "	16.—Hot Springs and Geysers.	Mr. S. L. Penfield.
VIII.	Friday, "	19.—The Bermuda Islands.	Prof. Wm. N. Rice.
IX.	Tuesday, "	23.—Glaciers.	Prof. Brewer.
X.	Friday, "	26.—Dialect in Fiction.	Mr. Wm. Henry Bishop.
XI.	Tuesday, "	30.—The Inventor.	Prof. Platt.
XII.	Friday, April	2.—Social Life in Madrid.	Prof. Knapp.

Lectures on Military Science.

A course of lectures on Military Science, by officers of the U. S. Engineering School at Willets Point, was delivered in North Sheffield Hall as a part of the instruction in the School during the second term of the academic year 1885–86.

The order and subjects of the lectures were as follows:

I.	Friday, Feb. 25.	—Strategy and Grand Tactics.	1st Lieut. Henry E. Waterman, U. S. Engineers.
II.	Monday, March 1.	—Logistics.	1st Lieut. James L. Lusk, U. S. Engineers.
III.	Friday, " 5.	—Small Arms and their influence on Tactics.	1st Lieut. William C. Langfitt, U. S. Engineers.
IV.	Monday " 8.	—Artillery.	1st Lieut. George A. Zinn, U. S. Engineers.
V.	Friday, " 12.	—Fortification.	Capt. John G. D. Knight, U. S. Engineers.
VI.	Monday, " 15.	—Sea Coast Defense.	General H. L. Abbot, U. S. Engineers.

Anniversary.

The Exercises of the Graduating Class were held in North Sheffield Hall on the evening of Tuesday, June 22, 1886. The

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candidates for degrees with the subjects of the graduation theses of the Bachelors of Philosophy are given in the following schedule. The names in the first list are of those who stood highest in their respective courses. Those marked with an asterisk read theses in the evening.

CIVIL ENGINEERING. (1.)

HENRY HOLBROOK GLADDING, Ph.B., *New Haven*. On Municipal Engineering.

DYNAMIC ENGINEERS. (2).

WILLIAM WALLACE NICHOLS, Ph.B., *Manitou Springs, Col.* On the Construction of a Mogul Locomotive.

FRANKLIN ELDRED WORCESTER, B.A., Ph.B., *New York City*. On Continuous Brakes.

BACHELORS OF PHILOSOPHY. (61.)

SILAS WARREN BARTLETT (Select), *South Orange, N. J.* On the Government Telegraph.

HENRY WILLIAM BLAKE (Civil Engineering), *New Haven*. On the Theory of the Telephone.

JOSEPH AUGUSTUS BLAKE, B.A. (Biology), *New Haven*. On the Relative Absorption of Antimony by the Tissues and Organs of the Body.

*JOHN MARVIN BLAKELEY (Select), *St. Paul, Minn.* On Federal Aid to Common Schools.

*PERCIVAL RANNEY BOLTON (Biology), *Cleveland, O.* On the Albumose Bodies formed from Egg-albumin by the Action of Pepsin-hydrochloric Acid.

*THEODORE NEWTON CASE (Dynamic Engineering), *Hartford*. On Natural Burning Gas.

JOHN CHAMBERLAIN (Select), *Kansas City, Mo.* On Building Associations.

FREDERICK WILLIAM DARLINGTON (Dynamic Engineering), *West Chester, Pa.* On Electrical Railways.

ALEXANDER HARRISON DAVIS (Select), *Watertown*. On the Status of the New England Farmer.

JOSEPH OSTERMAN DYER (Chemistry), *Galveston, Tex.* On the Halogen Derivatives of Oxanilide and New Acids made from them.

JAMES EUGENE GREENEBAUM (Chemistry), *Chicago, Ill.* On the Separation of Zinc by Hampe's Method.

HARRY CLOYD HAMILL (Select), *Georgetown, Col.* On the Silver Question.

*DAVID NEIL HARPER (Chemistry), *Shippensburg, Pa.* On the Quantitative Separation of Beryllium from Aluminum.

WILLIS BENJAMIN HERR (Select), *Denver, Col.* On the Removing Power of the President.

WILLIAM BARLOW HILL (Civil Engineering), *Greenfield Hill*. On Reservoirs and Sources of Water Supply.

*ABRAHAM LINCOLN HYDE (Civil Engineering), *New Haven*. Review of the N. Y. and N. H. Railway Bridge over the Housatonic River.

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*WILLIAM DAVID JOHNSON (Dynamic Engineering), *New Haven.* On the Nature and Extent of the Influence of the Reciprocating Parts of a Locomotive on its Steadiness.

HARRIE SHELDON LEONARD (Civil Engineering), *Washington, D. C.* On the Methods and Results of the United States Geological Survey.

EDWIN FRANK MEYER (Select), *Chicago, Ill.* On Beef Production in the United States.

*GEORGE EUSTIS POTTS (Agriculture), *Philadelphia, Pa.* On Sorghum Sugar Cane.

SAMUEL BOSTWICK ROBBINS (Civil Engineering), *Lakeville.* On the Salisbury Iron Region.

*EMANUEL FRANK SELZ (Select), *Chicago, Ill.* On the Punishment of Crime.

WILLIAM SANDERS TEVIS (Civil Engineering), *San Francisco, Cal.* On Irrigation in California.

CALVERT TOWNLEY (Dynamic Engineering), *Cincinnati, O.* On Rotary Fans and their Application to the Ventilation of Mines and Large Buildings.

*HENRY HAYES WADSWORTH (Civil Engineering), *Glencoe, Minn.* On the Straightening of West River.

GILBERT LINCOLN HUSTED ARNOLD (Dynamic Engineering), *Stamford.* On the Corliss Valve Gear.

WILLIAM WALLACE ATTERBURY (Dynamic Engineering), *Detroit, Mich.* On the Westinghouse Automatic Air Brake, as Applied to the Driving Wheels of Locomotives

HOWARD CONE BOLTON (Select), *Cleveland, O.* On Insects Injurious to Agricultural Products in the United States.

THOMAS STODDARD BRONSON (Biology), *New Haven.* On the Influence of Silver Nitrate on Ferment Action, Studied Quantitatively.

LOUIS WHITFORD BOND (Select), *New York City.* On Arctic Regions.

HARRY LOCKWOOD BURNS (Civil Engineering), *Milford.* On Foundations under Water.

JOHN EDWIN DOANE (Select), *Chicago, Ill.* On the City of Pullman, Ill.

LEWIS EMERSON CADWELL (Chemistry), *New Haven.* On the Action of Bromine on Basic Cupric Nitrate.

HARVEY FARRINGTON (Civil Engineering), *Croton, N. Y.* On the Water Supply of New York.

JOSEPH ESSEX FITZSIMONS (Dynamic Engineering), *Waterbury.* On Compressed Air, as Applied to Driving Street Cars.

ROBERT ELDER FORSTER (Select), *Harrisburg, Pa.* On the Coal Formation of Pennsylvania.

WILLIAM WASHINGTON GORDON, 3D (Civil Engineering), *Savannah, Ga.* On Railroad Commissions.

EVERETT MASON GRIMES (Dynamic Engineering), *Oakland, Cal.* On Krom's Method of Milling Ores.

FRANK SPERRY HARRISON (Civil Engineering), *New Haven.* On Cantilever Bridges.

JAY RUSSELL HICKOX (Civil Engineering), *South Britain.* On the Use of Steel and Iron in Construction.

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ABRAHAM LINCOLN HOWES (Dynamic Engineering), *Black Rock.* On Coal Elevators.

WILLIAM EVELYN HUTCHINGS (Dynamic Engineering), *Louisville, Ky.* On the Steam Engine Indicator and Indicator Diagrams.

MORRISON THOMAS HUTCHINSON (Biology), *Brooklyn, N. Y.* On the Influence of Uranium Salts on the Amylolytic Action of Saliva and on the Proteolytic Action of the Gastric and Pancreatic Juices.

THOMAS COGGESHALL KNOWLES (Dynamic Engineering), *San Francisco, Cal.* On Cable Railways, as Exemplified by the Market Street Cable Railway of San Francisco.

CORNELIUS FAY LYNDE (Select), *Rock Island, Ill.* On the Clearing-house System.

MAHLON HENRY MARLIN (Dynamic Engineering), *New Haven.* On some Modern Military Fire Arms.

FREDERICK ANDERSON MARSH (Select), *Kansas City, Mo.* On the Manufacture of Linseed Oil.

CONRAD HENRY MATTHIESSEN (Chemistry), *Cornwall, N. Y.* On Parabromorthoazoacetanilide, a New Compound.

GEORGE PERKINS MILLER (Civil Engineering), *Utica, N. Y.* On the Topography of the State of New York.

HENRY WHITE PATTEN (Dynamic Engineering), *North Haven.* On Electric Lighting.

WILLIAM ACKER RICE (Select), *St. Paul, Minn.* On Prison and Prison Discipline.

ARTHUR JONES RICHMOND (Dynamic Engineering), *Providence, R. I.* On the Hydraulic Elevator; its Method of Operation and its Capabilities.

REGINALD RONALDS (Dynamic Engineering), *New York City.* On Marine Engines and Boilers of To-day.

ALEXANDER HOLLEY RUDD (Dynamic Engineering), *Lakeville.* On Mountain Railways.

HENRY RUSTIN (Chemistry) *Omaha, Nebr.* On a New Basic Zinc Nitrate.

JOHN METCALFE THOMAS (Agricultural), *New York City.* On the Utility Horse of America.

GEORGE POLLOK DEVEREUX TOWNSEND (Civil Engineering), *Middletown.* On Cable Railways.

THOMAS BRODHEAD VAN BUREN, JR. (Select), *Englewood, N. J.* On the Agriculture of Japan.

CHARLES WILCOX (Civil Engineering), *Omaha, Nebr.* On Wind Power and its Utilization.

ROCKWELL AMASA WILLIAMS (Dynamic Engineering), *Canterbury.* On the Turbine; with a Discussion of the Hercules Wheel.

WILLIS STOUGHTON WILLIAMS (Select), *Minneapolis, Minn.* On the Flouring Industry of Minneapolis.

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Prizes.

CLASS OF 1886.

For excellence in Civil Engineering, the prize awarded to HENRY HAYES WADSWORTH, *Glencoe, Minn.*

For excellence in Dynamic Engineering, the prize awarded to WILLIAM DAVID JOHNSON, *New Haven.*

For excellence in German, the prize awarded to HENRY WILLIAM BLAKE, *New Haven.*

CLASS OF 1887.

For excellence in the Mathematics of Junior Year, the prize awarded to ROBERT FISHER GIBSON, *York, Pa.*, with honorable mention of ROBERT CLAYTON AUGUR, *West Haven*, and EDGAR BURTON HARGER, *Oxford.*

CLASS OF 1888.

For excellence in all the Studies of Freshman Year, the prize awarded to PERCEY FRANKLYN SMITH, *New Haven*, with honorable mention of EDWIN HOYT LOCKWOOD, *New Canaan*, and FRANK HAROLD FARQUHAR, *York, Pa.*

For excellence in Chemistry, the prize awarded to PERCEY FRANKLYN SMITH, *New Haven*, with honorable mention of EDWIN HOYT LOCKWOOD, *New Canaan*, FRANK HAROLD FARQUHAR, *York, Pa.*, and WILLIAM CLARKE CATLIN, *Providence, R. I.*

For excellence in Physics, the prize awarded to PERCEY FRANKLYN SMITH, *New Haven*, with honorable mention of ARTHUR CHAMBERS ALEXANDER, *Honolulu, H. I.*, FRANK HAROLD FARQUHAR, *York, Pa.*, EDWIN HOYT LOCKWOOD, *New Canaan*, and FRANK NEHEMIAH WATERMAN, *New Britain.*

For excellence in German, the prize awarded to PERCEY FRANKLYN SMITH, *New Haven*, with honorable mention of FRANK HAROLD FARQUHAR, *York, Pa.*, and ADDISON GRAVES, *New London.*

For excellence in Mechanical Drawing, the prize divided between EDWIN RICHARD HODGE *Washington, D. C.*, EDWIN WRIGHT ROBINSON, *New Haven*, PERCEY FRANKLYN SMITH, *New Haven*, and FRANK NEHEMIAH WATERMAN, *New Britain.*

For excellence in Mathematics, the prize awarded to PERCEY FRANKLYN SMITH, *New Haven*, with honorable mention of EDWIN HOYT LOCKWOOD, *New Canaan*, and MORGAN WALCOTT, *New York City.*

For excellence in English Composition, 1st prizes, EDWIN RICHARD HODGE, *Washington D. C.*, PERCEY FRANKLYN SMITH, *New Haven;* 2nd prizes, GEORGE SNOWDEN HOWLAND, *Newport, R. I.*, SAMUEL HARKNESS MCCREA, *Chicago, Ill.;* 3d prizes, ARTHUR CHAMBERS ALEXANDER, *Honolulu, H. I.*, GEORGE DAVID COLTON, *Collinsville*, FRANK HAROLD FARQUHAR, *York, Pa.*, ADDISON GRAVES, *New London*, FELIX KLEEBERG, *New Haven*, EDWARD HOYT LOCKWOOD, *New Canaan.*

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PROGRAMME OF STUDIES

AND

CATALOGUE,

FOR THE COLLEGE YEAR, 1886-87.

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CALEN

1886.		
23 Sept.	Thursday,	F
23 Dec.	Thursday,	F
1887.		
6 Jan.	Thursday,	S
6 April,	Wednesday,	S
13 April,	Wednesday,	S
28 June,	Tuesday,	M
28 June,	Tuesday,	A
29 June,	Wednesday,	C
30 June,	Thursday,	E
1, 2 July,	Friday, Sat.,	
		Su
20, 21 Sept.	Tues., Wedn.,	E
22 Sept.	Thursday,	F
22 Dec.	Thursday,	F

ABBREVI

S. H. - - - -
N. S. H. - - - -
TR. - - - - -
D. - - - - -
F. - - - - -
E. - - - - -
W. - - - - -
P. M. - - - -
A. - - - - -

the buildings belonging to the Shef
d from 1 to 21 are in Sheffield Hall; f

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HENRY C. KINGSLEY, M.A., (5 TR.) 23 Hillhouse av.

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GOVERNING BOARD.

APPOINTED BY THE CORPORATION OF YALE COLLEGE.

President.

REV. TIMOTHY DWIGHT, D.D., LL.D., (7 TR.) 126 College st.

Director.

GEORGE J. BRUSH, (3 S. H.) 14 Trumbull st.

Professors.

ARRANGED IN THE ORDER OF THEIR GRADUATION.

CHESTER S. LYMAN,
Astronomy, Theoretical and Practical. (39 N. S. H.) 88 Trumbull st.

WILLIAM D. WHITNEY,
Linguistics and French. (205 D.) 227 Church st.

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Mineralogy. (3 S. H.) 14 Trumbull st.

SAMUEL W. JOHNSON,
Theoretical and Agricultural Chemistry. (12 S. H.) 54 Trumbull st.

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JOHN E. CLARK,
Mathematics. (40 N. S. H.) 30 Trumbull st.

DANIEL C. EATON,
Botany. (41 N. S. H.) 70 Sachem st.

CHARLES B. RICHARDS,
Mechanical Engineering (HIGGIN *Professor*). (45 N. S. H.) 43 Elm st.

THOMAS R. LOUNSBURY,
English. 22 Lincoln st.

OSCAR D. ALLEN,
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WILLIAM G. MIXTER,
Chemistry. (8 T. H.) 144 Edwards st.

A. JAY DUBOIS,
Civil Engineering. (45 N. S. H.) 258 Bradley st.

CHARLES S. HASTINGS,
Physics. (30 N. S. H.) 191 Bradley st.

HENRY W. FARNAM,
Political Economy and History. 43 Hillhouse av.

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Physiological Chemistry. (5 S. H.) 32 Trumbull st.

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LECTURERS, INSTRUCTORS AND ASSISTANTS.

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Elocution. (150 F.) 200 Temple st.

JOHN H. NIEMEYER, Professor in Yale School of Fine Arts,
Free Hand Drawing.

FREDERICK R. HONEY,
Descriptive Geometry and Projection Drawing. (53 N. S. H.) 14 Lincoln st.

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Kinematics and Machine Design. (45 N. S. H.) 19 Warren pl.

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HORACE L. WELLS,
Analytical Chemistry. 14 S. H.

SAMUEL E. BARNEY,
Mathematics and Civil Engineering. 363 Elm st.

ALTON W. LEIGHTON,
Drawing. 129 College st.

LOUIS V. PIRSSON,
Analytical Chemistry. 8 Prospect pl.

WILLIAM PRICE,
French. 139 Elm st.

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LOUIS STADTMUELLER, 43 Whitney av.

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ANTON PFEIFER, 55 Lock street.

JANITOR OF NORTH SHEFFIELD HALL.

GEORGE W. STODDARD, 82 Mansfield street.

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GRADUATE STUDENTS.

John Alpheus Allen, PH.B.	*New Haven*	823 Chapel st.
Arthur Nathaniel Alling, B.A.	*New Haven*	120 Sherman av.
Samuel Eben Barney, C.E.	*New Haven*	315 Orange st.
Malcom Booth, PH.B.	*New Haven*	175 Oak st.
Herbert DeWitt Carrington, PH.B.	*New Haven*	1169 Chapel st.
Theodore Newton Case, PH.B.	*Hartford*	287 York st.
Alfred Cowles, Jr., B.A.	*Chicago, Ill.*	1173 Chapel st.
George Wyckoff Cummins, PH.B.	*Vienna, N. J.*	55 N. S. H.
George Francis Garneau, B.A. St. Louis University.	*St. Louis, Mo.*	126 High st.
Edmund Otis Hovey, B.A.	*Minneapolis, Minn.*	90 N. M.
Duane Judson Kelsey, PH.B.	*Killingworth*	Killingworth.
Comilo Enrique Pani, B.S. College of the Christian Brothers, St. Louis, Mo.	*Aguacalientes, Mexico*	31 Broadway.
Louis Valentine Pirsson, PH.B.	*New York City*	8 Prospect pl.
Julius Howard Pratt, Jr., B.A.	*Montclair, N. J.*	187 C.
Sidney Armour Reeve, PH.B.	*Dayton, O.*	409 Temple st.
James Alward Seymour, PH.B.	*Auburn, N. Y.*	A.
William Tuttle Shepard, PH.B.	*Bristol*	A.
Philemon Tecumseh Sherman, B.A. St. Louis University.	*St. Louis, Mo.*	126 High st.
Calvert Townley, PH.B.	*Cincinnati, O.*	101 W.
Curtiss Chauncey Turner, PH.B.	*Omaha, Nebr.*	391 Temple st.
George Elliot Verrill, PH.B.	*New Haven*	86 Whalley av.
Henry Stephens Washington, B.A.	*New Haven*	27 S.
Charles Percy Willcox, B.S. Swarthmore College.	*Media, Pa.*	84 Wall st.

GRADUATE STUDENTS, 23.

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SENIOR CLASS.

Henry Frederick Adams	*Westport*	293 George st.
Robert Clayton Augur	*West Haven*	West Haven.
Elmer Ellsworth Bennett	*Plainfield*	330 Orange st.
Walter Pierpont Bigelow	*New Haven*	278 Orange st.
Herbert Spencer Bullard	*Hartford*	46 N. S. H.
Richard Augustus Chapman	*Rye, N. Y.*	116 W.
William Henry Coburn	*Indianapolis, Ind.*	36 Elm st.
Harry Fitch Coleman	*Logansport, Ind.*	1161 Chapel st.
Lewis Atterbury Conner	*New Albany, Ind.*	389 Temple st.
David Mark Cummings	*Chicago, Ill.*	36 Elm st.
Julius Gilbert Day	*Seymour*	205 Orange st.
William Greenhow Doane	*Omaha, Nebr.*	64 High st.
Edward Warburton Durant, Jr.	*Stillwater, Minn.*	43 College st.
Isadore Dyer, Jr.	*Galveston, Tex.*	88 Wall st.
Arthur Mansfield Everit	*New Haven*	161 Orange st.
Raymond Thomson French	*Seymour*	36 Elm st.
Francis Frederick Georger	*New York City*	36 Elm st.
Robert Fisher Gibson	*York, Pa.*	88 Wall st.
Charles Joseph Goldmark	*New York City*	36 High st.
Wilfred Elizur Griggs	*Waterbury*	389 Temple st.
George Conradt Ham	*Washington Hollow, N. Y.*	44 Elm st.
Harry Leon Hamlin	*Chicago, Ill.*	43 College st.
Edgar Burton Harger	*Oxford*	150 College st.
Herbert Leopold Hart	*Chicago, Ill.*	1161 Chapel st.
James Henry Hayden	*New York City*	1161 Chapel st.
William Brisbane Hickox	*Litchfield*	A.
Marvin D. Hubbell	*New York City*	138 York st.
Joseph Cooke Jackson, Jr.	*New York City*	60 W.
Lawrence Bates Jenckes	*Stamford*	116 W.
Leonard Abbott Jenkins	*Dresden, Saxony*	88 Wall st.
Charles Sherman Jewett	*Buffalo, N. Y.*	88 Wall st.
John Edwin Judson	*New Haven*	142 St. John st.
Frederick Sheffield Kellogg	*Utica, N. Y.*	43 College st.
Grayson Guthrie Knapp	*Auburn, N. Y.*	86 W.
Edward Linsley Maltby	*Northford*	149 College st.
Harley James Morrison	*Cincinnati, O.*	60 W.
William Partridge Ordway	*Boston, Mass.*	44 Elm st.
Edmund Bishop Patterson	*Allegheny City, Pa.*	1161 Chapel st.
Frank Adelbert Paul	*New Haven*	13 Washington st.
Charles Eugene Phillips	*Southington*	14 Prospect pl.
William Thomas Rainey	*Cleveland, O.*	36 W.
Harris Smith Reynolds	*Poughkeepsie, N. Y.*	43 College st.
John Robert Wheaton Sargent	*Chicago, Ill.*	36 Elm st.
William Marcelin Scaife	*Allegheny City, Pa.*	203 York st.

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Oscar Harmon Short	*New York City*	43 College st.
Edward Arthur Smith	*Middletown*	1161 Chapel st.
Frink Mansfield Smith	*East Haven*	East Haven.
Edwin Starr Sperry	*Ansonia*	41 High st.
Merton Pierpont Stevens	*New Haven*	561 Howard av.
Arthur Peale Summers	*Colorado Springs, Col.*	126 High st.
Howard Beecher Tuttle	*Naugatuck*	44 Elm st.
Alfred John Wakeman	*Green's Farms*	293 George st.
Frank Otto Walther	*Brooklyn, N. Y.*	88 Wall st.
Nathaniel P. Washburn	*Bridgewater, Mass.*	149 College st.
Frank Warren Wentworth	*Chicago, Ill.*	1161 Chapel st.
Edward Gilbert Williams	*Essex*	47 Stanley st.
George Henry Wood	*Dayton, O.*	88 Wall st.
Robert McKnight Woods	*New Haven*	364 George st.

SENIORS, 58

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JUNIOR CLASS.

Arthur Chambers Alexander	*Honolulu, H. I.*	85 w.
John Childe Anderson	*Sing Sing, N. Y.*	65 w.
Joseph Albright Archbald	*Scranton, Pa.*	36 Elm st.
Gardner Ball, Jr.	*San Francisco, Cal.*	36 Elm st.
William Hill Bean	*New Haven*	40 Pleasant st.
Charles Bart Berger	*Denver, Col.*	88 Wall st.
George Bart Berger	*Denver, Col.*	88 Wall st.
Marshall Latham Bond	*New York City*	43 College st.
William Tillinghast Bull	*Newport, R. I.*	35 High st.
George Robert Carter	*Honolulu, H. I.*	43 College st.
William Clarke Catlin	*Providence, R. I.*	27 Lynwood st.
James Henry Coleman	*New York City*	62 w.
George David Colton	*Collinsville,*	154 Humphrey st.
John Nesbitt Conyngham	*Wilkesbarre, Pa.*	120 High st.
Charles Edward Curtiss	*New Haven*	138 Dwight st.
Richard Sydney Curtiss	*Stratford*	103 Wall st.
Jesse Chase Dann	*Buffalo, N. Y.*	36 Elm st.
Henry Lewis Davis,	*Wallingford*	1010 Chapel st.
George Howard Davison	*New York City*	43 College st.
William Henry Davol, Jr.	*Brooklyn, N. Y.*	103 Wall st.
Carlton Melville DeWolf	*New York City*	389 Temple st.
Robert Russel Dickey	*Dayton, O.*	88 Wall st.
John Eufemio Dockendorff	*Brooklyn, N. Y.*	88 Wall st.
John Ambrose Doolittle	*New Haven*	219 Orange st.
John Feeter Easterbrook	*New Haven*	82 York sq.
Henry Hays Ellis	*Oxford, Me.*	8 Prospect pl.
Frank Harold Farquhar	*York, Pa.*	88 Wall st.
John Ellis Field	*Denver, Col.*	126 High st.
Richard Huntington Franchot	*Schenectady, N. Y.*	43 College st.
Pedro Florentino Francke	*New York City*	43 College st.
Deane Funk	*McLean, Ill.*	67 w.
Henry Kellogg Goetchius	*New York City*	43 College st.
James Douglas Gold	*West Cornwall*	65 Grove st.
Addison Graves	*New London*	85 w.
Franklin Moses Gray	*Chicago, Ill.*	46 Elm st.
Howard Greer, Jr.	*Chicago, Ill.*	6 Prospect pl.
Matthew Griswold, Jr.	*Erie, Pa.*	57 w.
Stephen Benedict Grummond, Jr.	*Detroit, Mich.*	395 Temple st.
Fred R. Hamlin	*Chicago, Ill.*	1179 Chapel st.
Charles Merritt Heminway	*Watertown*	1142 Chapel st.
Noble Foster Hoggson	*New Haven*	126 York st.
George Snowden Howland	*Newport, R. I.*	43 College st.
Howard Livingstone Isbell	*Union City*	6 Prospect pl.
Harry Garrybrant Jenner	*Dayton, O.*	125 Dwight st.

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Harry Lydstone Johnson	*New Haven*	25 Eld st.
Cyrus Field Judson	*New York City*	43 College st.
George Converse Kimball	*Hartford*	64 w.
Felix Kleeberg	*New Haven*	14 Orange st.
Edward Lambert Leeds	*Stamford*	120 High st.
Thomas Albert Legler, Jr.	*Dayton, O.*	1182 Chapel st.
Louis LeSassier	*New Orleans, La.*	72 w.
Edwin Hoyt Lockwood	*New Canaan*	103 Wall st.
Samuel Harkness McCrea, Jr.	*Chicago, Ill.*	46 Elm st.
George Grant Mason	*Milburn, Ill.*	62 w.
William Smith Mason	*Milburn, Ill.*	62 w.
Charles Griffin Miller	*New Rochelle, N. Y.*	36 Elm st.
Edward Steward Moore	*New London*	409 Temple st.
James Augustus Nelson	*Bridgeport*	1010 Chapel st.
Edward Marshall Ney	*Hartford*	59 Prospect st.
Charles Norris, Jr.	*New York City*	71 w.
Elbert Ellsworth Norton	*New Haven*	33 Pearl st.
Selden Yale Osborn	*New Haven*	232 York st.
Edward Horatio Parker	*Detroit, Mich.*	43 College st.
Franklin T. Parlin	*Casselton, Dakota*	1010 Chapel st.
Frank Wyman Parmerter	*Plattsburgh, N. Y.*	39 Lynwood st.
John Erskine Patrick	*Omaha, Nebr.*	64 High st.
Daniel Tucker Coffin Perkins	*San Francisco, Cal.*	36 Elm st.
Francis Cole Pratt	*Hartford*	36 Elm st.
John Goodell Prouty	*Spencer, Mass.*	46 Elm st.
George Brinckerhoff Richards	*New Haven*	313 York st.
Edwin Wright Robinson	*New Haven*	255 Ferry st.
Henry Charles Schwab	*Chicago, Ill.*	66 w.
Charles Kirtland Shelton	*Bridgeport*	1010 Chapel st.
Shiukichi Shigemi	*Imabari, Japan*	330 Orange st.
Orville Emerson Sloat	*New Haven*	170 York st.
Ernest Ellsworth Smith	*New Haven*	16 Hughes pl.
Percey Franklyn Smith	*New Haven*	13 Home pl.
Ralph Hebert Smith	*Waterbury*	389 Temple st.
Frederick William Spanutius	*New Haven*	180 Chestnut st.
Stanley Matthews Stagg	*Frankfort, Ky.*	201 Orange st.
Charles Weaver Stewart	*Newport, R. I.*	35 High st.
Howard Canning Taylor	*Green's Farms*	65 Grove st.
William Conquest Tucker	*New York City*	61 w.
Charles Alling Tuttle	*New Haven*	364 Orchard st.
Morgan Walcott	*New York City*	389 Temple st.
Charles Spencer Wells	*Southport*	86 Whitney av.
Ralph McIntosh Wilcox	*Portland*	59 Grove st.
Frank Clark Woodruff	*Orange*	41 High st.

JUNIORS 88

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FRESHMAN CLASS.

William Belknap Allen	*Pewee Valley, Ky.*	238 York st.
James Bradshaw Bailey	*Harrisburgh, Pa.*	1079 Chapel st.
Erdmann Dwight Baldwin	*Honolulu, H. I.*	421 Temple st.
Sherman Woodward Barker	*Woodbridge*	41 High st.
Louis Lawrence Barnum	*Thompsonville*	16 S. H.
William Bartlett Beckley	*New Haven*	300 Howard av.
Mark Spaulding Bradley	*East Jaffrey, N. H.*	136 College st.
William Dennison Breed	*Cincinnati, O.*	393 Temple st.
William Fances Breeze	*San Francisco, Cal.*	104 Wall st.
Bertram Loring Britton	*Cleveland, O.*	289 York st.
Frederick Willard Burgess	*New Haven*	Rock st., Westville.
Elton Goodrich Burroughs	*New York City*	67 Howe st.
George Tyler Burroughs, Jr.	*Chicago, Ill.*	55 Trumbull st.
Henry Studley Burroughs	*Chicago, Ill.*	55 Trumbull st.
Frank Arthur Busse	*New Haven*	3 Ridge st.
Perry Moore Caldwell	*Wheeling, W. Va.*	203 York st.
Jay Freeborn Carlisle	*Brooklyn, N. Y.*	7 Library st.
William Darrow Carter	*Waterbury*	38 High st.
Arthur Sanford Cheney	*New Haven*	45 Elm st.
Tecumseh Sherman Clark	*Pittsburgh, Pa.*	393 Temple st.
William Shiner Clawson	*Woodstown, N. J.*	1079 Chapel st.
William Hillard Conyngham	*Wilkes-Barre, Pa.*	120 High st.
Frank Marcus Cooper	*Kingston, Pa.*	395 Temple st.
Louis Julius Curtis	*Stamford*	109 York st.
Arthur Herbert Day	*New Haven*	310 York st.
Edward Hangary Day	*New Albany, Ind.*	393 Temple st.
Philip James Deering	*Portland, Me.*	238 York st.
Edwin Kirk Dillingham	*New Orleans, La.*	157 Orange st.
Louis Coert DuBois	*Hudson, N. Y.*	1169 Chapel st.
Frederick Howard Ellsworth	*Hartford*	1 Whalley av.
Harootum Enfiajian	*Harpoot, Turkey*	92 York sq.
Edward Everest	*Newark, N. J.*	90 Wall st.
Willis Judson Fenn	*Plymouth*	24 Dow st.
William Irving Ferrey	*Pittsfield, Mass.*	31 Trumbull st.
Theron Rockwell Field	*New York City*	154 Grove st.
Lloyd Wiegand Fisher	*Westtown, N. Y.*	339 Prospect st.
Hugh Neely Fleming	*Erie, Pa.*	393 Temple st.
Lewis Brown Gawtry	*New York City*	109 Wall st.
Harry Cromwell Gibbons	*Middletown*	59 Prospect st.
George Frank Goodale	*New Haven*	6 Prospect pl.
George Dexter Gregory	*Brooklyn, N. Y.*	337 Orange st.
Louis Montrose Haight	*Alameda, Cal.*	82 Wall st.
Henry Pierce Hall	*San Francisco, Cal.*	425 Temple st.
John Augustus Hartwell	*Unionville, N. Y.*	128 Temple st.

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Leland Howard	*Hartford*	64 w.
Arthur Grant Huntington	*Cleveland, O.*	77 w.
Gustave Erwin Huttelmaier	*Knoxville, Tenn.*	128 Temple st.
Adrian Muller Isham	*Englewood, N. J.*	17 College st.
Arthur Wiswell Jepson	*New Haven*	30 Grove st.
John Henry Klock, Jr.	*New Haven*	1201 Chapel st.
Edwin Forest Landy	*Cincinnati, O.*	101 w.
C. Carlton Lee	*Cleveland, O.*	285 York st.
Eugene Lentilhon	*New York City*	55 w.
George Alfred Lund	*West Stratford*	West Stratford.
David Lyman	*Middlefield*	128 High st.
Boynton Wells McFarland	*New Haven*	67 Mansfield st.
Frank Aloysius Maloney	*New Haven*	34 Ferry st.
Kingsley Walton Martin	*Staten Island, N. Y.*	133 College st.
Frederic Bausman Mathews	*Philadelphia, Pa.*	44 Elm st.
Ferris Jacobs Meigs	*New York City*	24 Home pl.
George Wellington Miles, Jr.	*Milford*	Milford.
John Raymond Mitchell	*Franklin, Pa.*	46 Elm st.
Augustus René Moën	*New York City*	109 Wall st.
Edwin Morrison	*Cincinnati, O.*	59 w.
Thomas Hunter Morrison	*Cincinnati, O.*	59 w.
William Brewster Morrison	*Willimantic*	134 College st.
William Belknap Newberry	*New Haven*	73 Whitney av.
Roger Samuel Newell	*Bristol*	103 Park st.
Edwin Oppenheimer	*New Haven*	78 Lyon st.
Frank Lee Owen	*Oakland, Cal.*	82 Wall st.
Gains Foster Paddock	*St. Louis, Mo.*	175 Oak st.
Kenyon Vickers Painter	*Cleveland, O.*	155 Elm st.
William Henry Pierce	*South Britain*	40 Lynwood st.
Henry Adams Plumer	*Philadelphia, Pa.*	46 Elm st.
John Francis Poëy	*Havana, Cuba*	55 Prospect st.
Edwin Read	*Brooklyn, N. Y.*	1079 Chapel st.
Irwin Rew	*Chicago, Ill.*	90 Wall st.
Henry Work Rianhard	*New York City*	133 College st.
Paul Skiff Robinson	*New Haven*	137 Edwards st.
James Woodrow Ruthven	*Scranton, Pa.*	136 College st.
Alfred Schwab	*Chicago, Ill.*	66 w.
Ernest Elisha Sperry	*Waterbury*	226 Crown st.
Paul Sheafer	*Pottsville, Pa.*	105 Wall st.
Frederick Robinson Shepard	*Minneapolis, Minn.*	68 w.
Arthur Bertram Skelding	*Riverside*	65 Grove st.
Albert Kingsley Spencer	*Cleveland, O.*	68 w.
George Jarvis Spencer	*Old Saybrook*	411 Temple st.
Charles Emerson Stone	*Spencer, Mass.*	143 York st.
Lewis Hobart Sweetser	*San Francisco, Cal.*	393 Temple st.
Henry Hutchins Sykes	*New Haven*	114 High st.
Orien Edward Taft	*Chicago, Ill.*	104 Wall st.
Abraham Louis Thalheimer	*New Haven*	100 St. John st.

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Benjamin Comfort Thomas	*Columbus, Ind.*	38 Elm st.
Harry George Tombler	*Easton, Pa.*	1079 Chapel st.
Charles Newman Traver	*Hudson, N. Y.*	137 College st.
Clarence Beecher Twitchell	*New Haven*	68 Asylum st.
Harry Mighels Verrill	*Portland, Me.*	86 Whalley av.
William Walker Weare	*Chicago, Ill.*	154 Grove st.
Robert Taylor Wheeler	*Jersey City, N. J.*	84 Wall st.
Guthrie Minor Wilson	*Bardstown, Ky.*	393 Temple st.
John Albert Woodruff	*Windsor Locks*	55 Prospect st.
Bertram G. Work	*Akron, O.*	1179 Chapel st.
William Charles Wurtemberg	*Willink, N. Y.*	64 State st.
Thomas Henry Yardley	*Newport, R. I.*	143 College st.

FRESHMEN, 104

SPECIAL STUDENTS NOT CANDIDATES FOR A DEGREE.

Edmund Brown	*Norfolk*	233 York st.
Joseph Stanley Brown	*Washington, D. C.*	14 S. H.
Abner Reeder Chambers	*Trenton, N. J.*	118 York st.
Louis Stanley Ferry	*New Haven*	261 Crown st.
Willis Phelps	*Springfield, Mass.*	53 Prospect st.
Warren A. Spalding	*New Haven*	89 Church st.

SPECIAL STUDENTS, 6.

SUMMARY.

Graduates,	23
Seniors,	58
Juniors,	88
Freshmen,	104
Special,	6
	279

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SHEFFIELD SCIENTIFIC SCHOOL

I.

OBJECTS.

THE SHEFFIELD SCIENTIFIC SCHOOL is devoted to instruction and researches in the mathematical, physical and natural sciences, with reference to the promotion and diffusion of science, and also to the preparation of young men for such pursuits as require especial proficiency in these departments of learning. It is one of the Departments of Yale University, like the law, medical, theological, and art schools, having its separate funds, buildings, teachers and regulations, but governed by the Corporation of Yale College, which appoints the professors and confers the degrees. It is, in part, analogous to the academic department, or classical college, and, in part, to the professional schools.

The instruction is intended for two classes of students :—

I. Graduates of this or of other colleges, and other persons qualified for advanced or special scientific study.

II. Undergraduates who desire a training chiefly mathematical and scientific, in less part linguistic and literary, for higher scientific studies, or for various other occupations to which such training is suited.

II.

HISTORY AND ORGANIZATION.

The School was commenced in 1847. In 1860, a convenient building and a considerable endowment were given by Joseph E. Sheffield, Esq., of New Haven, whose name, at the repeated request of the Corporation of Yale College, was afterward attached to the foundation. Mr. Sheffield afterward frequently and munificently increased his original gifts.

In 1863, by an act of the Connecticut Legislature, the national grant for the promotion of scientific education (under the congressional enactment of July, 1862), was given to this department

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of Yale University. Since that time, and especially since the autumn of 1868, numerous liberal gifts have been received from the citizens of New Haven, and from other gentlemen in Connecticut and New York, for the endowment of the School, and the increase of its collections.

The action of the State led to the designation by law of a State Board of Visitors, consisting of the Governor, Lieutenant-Governor, three senior Senators, and the Secretary of the State Board of Education: and this Board, with the Secretary of the Scientific School, is also the Board for the appointment of students to hold the State scholarships.

The Governing Board consists of the President of Yale University and the professors who are permanently attached to the School. There are several other instructors associated with them, a part of whom are connected with the other departments of the University.

III.

BUILDINGS AND APPARATUS.

The two buildings in which the work of instruction in the Scientific School is mainly carried on, are called Sheffield Hall and North Sheffield Hall; but instruction in Mineralogy, Geology, and Biology, including Zoölogy and Comparative Anatomy, is now given entirely in the Peabody Museum and Free Hand Drawing in the Art School. These buildings contain a large number of recitation and lecture rooms, a hall for public assemblies and lectures, chemical and metallurgical laboratories, besides studies for some of the professors, where their private technical libraries are kept.

The following is a summary statement of the collections belonging to the School:

1. Laboratories and Apparatus in Chemistry, Metallurgy, Physics, and Zoölogy
2. Metallurgical Museum of Ores, Furnace Products, etc.
3. Agricultural Museum of Soils, Fertilizers, useful and injurious insects, etc.
4. Collections in Zoölogy.
5. Astronomical Observatory, with an equatorial telescope by Clark and Sons of Cambridge, a meridian circle, etc.
6. A collection of Mechanical Apparatus, constituting the "Collier Cabinet."
7. Models in Architecture, Geometrical Drawing, Civil Engineering, Topographical Engineering and Mechanics; diagrams adapted to public lectures; instruments for field practice.
8. Maps and Charts, topographical, geological, hydrographical, etc.

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The herbarium of Professor Brewer, and the astronomical instruments of Professor Lyman, are deposited in the buildings. Professor Eaton's herbarium, near at hand, is freely accessible. Students also have access to the various laboratories and collections in Natural Science in the Peabody Museum.

Students are also admitted, under varying conditions, to the University and Society libraries, the College Reading Room, the School of the Fine Arts, and the Gymnasium.

IV.

THE LIBRARY.

The special technical library of the Scientific School consists of about five thousand volumes. Included in this is the "Hillhouse Mathematical Library" of twenty-four hundred volumes, collected during a long series of years by Dr. William Hillhouse, and in 1870 purchased and presented to the Institution by Mr. Sheffield. A catalogue of this collection forms a supplement to the Annual Report of the Governing Board of 1870. All the prominent scientific journals of this country and of Europe, together with the proceedings of foreign academies, and scientific societies, can be found either in this library or in the University Library to which students have access.

V.

INSTRUCTION FOR GRADUATE AND SPECIAL STUDENTS.

Persons who have gone through undergraduate courses of study, here or elsewhere, may avail themselves of the facilities of the School for more special professional training in the physical sciences and their applications; gaining in one, two, or three years, the degree of BACHELOR OF PHILOSOPHY or, in two additional years of Engineering study, that of CIVIL ENGINEER or of MECHANICAL ENGINEER.

Or, engaging in studies of a less exclusively technical character, they may become candidates for the degree of DOCTOR OF PHILOSOPHY. The instruction in such cases will be adapted to the particular needs and capacities of each student, and may be combined with that given by the graduate instructors in other departments of the University. This degree is conferred upon those who, having already taken a Bachelor's degree, engage as students in the

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Department of Philosophy and the Arts for not less than two years in assiduous and careful study. It is not given upon examination to those whose studies are pursued elsewhere. The requirements for it will in some cases exact of the student more than two years of post-graduate labor, especially so, wherever the course of undergraduate study has been, as in the Scientific School, of less than four years. The candidate must pass a satisfactory final examination, and present a thesis giving evidence of high attainment in the branches of knowledge to which he has attended. A good knowledge of Latin, German and French will be required in all cases, unless, for some exceptional reason, the candidate be excused by the Faculty. The graduating fee is ten dollars.

Subjects likely to receive special attention are suggested as follows:

Professor LYMAN, in the use of meridional and other astronomical instruments.

Professor DUBOIS, in the principles of thermodynamics, and utilization of heat as a source of power.

Professor RICHARDS, in mechanical engineering.

Professor HASTINGS, in selected subjects in physics, and guidance in laboratory work.

Professor BRUSH, in the analysis and determination of mineral species, and in descriptive mineralogy.

Professor JOHNSON, in theoretical, analytical, and agricultural chemistry.

Professor BREWER, in agriculture and forest culture and in physical geography.

Professor CLARK, in definite integrals, differential equations, analytical mechanics, the theory of numerical approximation, with the method of least squares.

Professor EATON, in structural and systematic botany, with reference to both flowering and cryptogamous plants.

Professor ALLEN, in analytical chemistry, and in metallurgy.

Professor VERRILL, and Professor SMITH, in zoölogy, comparative anatomy, and geology.

Professor CHITTENDEN, in physiological chemistry.

The same courses of study are open, for a longer or shorter time, to graduate students, who do not desire to become candidates for a degree.

Students who have taken the degree of Bachelor of Philosophy,

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may obtain the degree of CIVIL or of MECHANICAL ENGINEER at the end of two academical years, by pursuing the following higher course of study and professional training.

The course of study for the degree of CIVIL ENGINEER will comprise—

1. Higher Calculus. Higher Geometry. Theory of Numerical Operations.
2. Analytical Mechanics. Mechanics applied to engineering.
3. A Course of Construction and Design. Projects.
4. Practical Astronomy, with use of Instruments, computations, etc.

The course will occupy one year.

To secure the requisite amount of professional knowledge and practice, the candidate will be required to furuish a comprehensive report of the results of an examination into the existing condition of some special line of constructive art; or to present proper evidence that he has had actual charge in the field, for several months, of construction or surveying parties, or held some responsible position deemed equivalent to this.

An elaborate design must also be submitted of some projected work of construction, based upon exact data obtained from careful surveys made by the candidate, and comprising all the requisite calculations, and the necessary detailed drawings, and accompanied by full specifications of the work to be done, and the requirements to be met by the contractor.

The fee for this degree is five dollars.

The course of study for the degree of MECHANICAL ENGINEER will comprise—

1. Higher Calculus. Higher Geometry. Theory of Numerical Operations.
2. General Principles of Dynamics (Analytical Mechanics), including special application of these Principles to Dynamic problems.
3. Construction of Machines. Designs.
4. Preparation of theses on special subjects in Mechanical Engineering.

During the second year candidates will be permitted to employ such portion of their time as may be deemed advisable or necessary in the examination of engineering works and manufacturing establishments, and may also have the privilege of entering upon professional practice, provided it is done with the knowledge and consent of the Professor of Mechanical Engineering, and under such circumstances as shall appear to him to be favorable to professional progress.

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An elaborate thesis on some professional subject, with an original design, or project, accompanied by proper working drawings, will be required at the end of the second year.

The fee for this degree is five dollars.

SPECIAL STUDENTS.—For the benefit of those who, being fully qualified, desire to pursue particular studies without reference to the obtaining of a degree, special or irregular students are received in most of the departments of the School; not, however, in the Select Course or in the Freshman Class.

It should be distinctly understood that these opportunities are not offered to persons who are incompetent to go on with the special studies pursued by the regular classes, but are designed to aid those who, having received a sufficient preliminary education elsewhere, desire to increase their proficiency in special branches.

VI.

REQUIREMENTS FOR ADMISSION AND COURSES OF INSTRUCTION FOR UNDERGRADUATE STUDENTS.

TERMS OF ADMISSION.—Candidates must not be less than fifteen years of age, and must bring satisfactory testimonials of moral character from their former instructors or other responsible persons.

For admission to the Freshman Class the students must pass a thorough examination in the following subjects:

English—including grammar, spelling and composition. In grammar, Whitney's Essentials of English Grammar, or an equivalent.

History of the United States.

Geography.

Latin—(1) Simple exercises in translating English into Latin. (Smith's "*Principia Latina*," Part I, is named as indicating the nature and extent of this requirement, and an acquaintance with it will be required unless a satisfactory substitute is offered.) (2) Cæsar—six books of the Gallic War, or their equivalent. (As advantageous substitutes for the last three books of Cæsar may be suggested three books of Vergil's Æneid or a similar amount of Ovid.)

Arithmetic—Fundamental Operations, Least Common Multiple, Greatest Common Divisor, Common and Decimal Fractions, Denominate Numbers, including the Metric System of Weights and Measures; Percentages, including Interest, Discount, and Commission: Proportion, Extraction of the Square and Cube Roots.

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Algebra—Fundamental Operations, Fractions, Equations of the First Degree with one or several unknown quantities; Inequalities, Ratio and Proportion, Involution, including the Binomial Formula, for an entire and positive Exponent; Evolution, the Reduction of Radicals, Equations of the Second Degree, Progressions, Permutations and Combinations, the Method of Indeterminate Coefficients, Fundamental Properties of Logarithms, Compound Interest.

Geometry—Plane, Solid and Spherical; including fundamental notions of Symmetry, and examples of Loci and Maxima and Minima of Plane Figures.

Trigonometry—Including the Analytical Theory of the Trigonometrical Functions, and the usual formulæ; the Construction and Use of Trigonometrical Tables; and the Solution of Plane Triangles; so much, for example, as is contained in Newcomb's Trigonometry to Art. 79, or in Wheeler's, or Richards', or Wentworth's Plane Trigonometry, or in the Plane Trigonometry of Oliver, Wait and Jones. The Logarithmic and Trigonometric Tables furnished at the Examination will be Newcomb's (Henry Holt & Co., New York, 1882).

While no entrance examination is held in the *History of England*, candidates for admission are urgently advised to make themselves as familiar as possible with that subject; as a knowledge of it is essential to the most successful prosecution of some of the studies of the course.

Candidates will be allowed the option of passing on the above-named subjects in two successive years. In such cases they must present themselves for examination at the June examination of the first year in the following subjects or parts of subjects: *History of the United States, Geography, Arithmetic, Plane Geometry, and Algebra to Quadratic Equations.*

In order to have this preliminary examination counted, candidates must pass satisfactorily on four of the subjects; and notice of the intention to divide the examination must be given to Professor George J. Brush, Director of the School, on or before June 15.

For preparation in Algebra, Geometry, and Trigonometry, the recently published text-books of Professor Newcomb (Henry Holt & Co., New York), may, without indicating undue preference, be especially recommended. And to the candidate who prepares in other works, they may serve to indicate the extent and kind of attainments expected in the prescribed topics. Candidates who prepare in the Geometry of this author, may for the present omit the short chapters on Ellipse, Hyperbola, and Parabola; though they will find it advantageous to study them.

In his preparation in GEOMETRY the candidate should, as far as practicable, have suitable exercises in proving simple theorems and solving simple problems for himself. It is important, too, that he should be accustomed to the numerical application of geometric principles, and especially to the prompt recollection and use of the elementary formulæ of mensuration. In TRIGONOMETRY he should be exercised in applying the usual formulæ to a variety of simple reductions and

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transformations, including the solution of trigonometrical equations. Readiness and accuracy in trigonometrical calculations are also of prime importance to the candidate. If the use of logarithms is postponed in his preparation till Trigonometry is taken up (which is by no means necessary or advisable), he should then have abundant application of them to all forms of calculation occurring in ordinary practice, as well as those appearing in the solution of triangles. Finally, in all of his calculations, he should study the art of neat and orderly arrangement.

In LATIN the student should have such continued training in parsing as shall make him thoroughly familiar with declensions and conjugations, and with the leading principles of Syntax. To secure these results more effectually, the requirement has been adopted of simple exercises in translating English into Latin. As this course of exercises is designed solely as a preparation for reading, it should be begun at the earliest stage of Latin study. A very large proportion of the deficiencies in the Latin examination for several years past has been due to the neglect of the suggestions of this paragraph, and to the attempt to read a Latin author with totally inadequate grammatical preparation.

The examinations for admission in 1887 take place at North Sheffield Hall, on Thursday, Friday, and Saturday, June 30, July 1, 2 (beginning at 9 A. M. on Thursday); and on Tuesday and Wednesday, September 20, 21 (beginning at 9 A. M. on Tuesday. In general, examinations for admission to the Freshman Class of the *next* year can be held only in June and September as specified; if in any case sufficient reason exists for an exception to this rule, a special fee (not exceeding fifty dollars) will be charged.

In 1887, examinations (for the Freshman Class only) will also be held in Andover, Mass., in Chicago, in Cincinnati, and in San Francisco (beginning on Thursday, June 30, at 9 A. M.), at places to be announced in local newspapers of the day previous. Candidates who propose to be present are requested to send their names to Professor George J. Brush, Director of the School, before June 15. A fee of five dollars will be charged for admission to the examinations outside of New Haven.

Candidates for advanced standing in the undergraduate classes are examined, in addition to the preparatory studies, in those already pursued by the class they wish to enter. No one can be admitted as a candidate for a degree, later than at the beginning of the Senior year.

COURSES OF INSTRUCTION, occupying three years, are arranged to suit the requirements of various classes of students. The first year's work is the same for all; for the last two years the instruction is chiefly arranged in special courses.

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The special courses most distinctly marked out are the following:

(*a.*) In Chemistry; (*b.*) In Civil Engineering;
(*c.*) In Dynamical (or Mechanical) Enginering;
(*d.*) In Agriculture; (*e.*) In Natural History;
(*f.*) In Biology preparatory to Medical Studies;
(*g.*) In studies preparatory to Mining and Metallurgy;
(*h.*) In select studies preparatory to other higher studies.

The arrangement of studies is indicated in the annexed scheme. A fuller statement of the methods and character of the instruction will be found below, p. 50 ff. The number of hours given means, unless otherwise specified, hours per week.

FRESHMAN YEAR: INTRODUCTORY TO ALL THE COURSES.

FIRST TERM:—*German*—Whitney's Grammar and Reader, 3 hrs. *English*—Lounsbury's History of the English Language, 1 hr.; Exercises in composition. *Mathematics*—The Derivatives of Algebraic Functions; Fundamental Properties of Equations; Plane Analytical Geometry; 3 hrs. *Physics*—Recitations, 2 hrs.; with experimental lectures, 2 hrs. *Chemistry*—Recitations, 2 hrs.; laboratory practice, 2 hrs. *Elementary Drawing*—Practical Lessons in the Art School, 3 hrs.

SECOND TERM—*Language, Physics and Chemistry*—as stated above. *Mathematics*—Plane Analytical Geometry, continued; Spherical Trigonometry (Newcomb's); 3 hrs. *Physical Geography*—8 Lectures during the term. *Botany*—Gray's Lessons, 3 hours. *Drawing*—Principles of Orthographic Projection; Isometric Drawing with application to drawing from models and structures, and isometric construction of objects from their orthographic projections; Projections of Shadows; Shading and tinting; Sections; Developments and Intersections of Surfaces; 4 hrs.

For the Junior and Senior years the students select for themselves one of the following Courses.

(a.) IN CHEMISTRY.

JUNIOR YEAR:

FIRST TERM:—*Organic Chemistry*—Lectures and Recitations, 2 hrs. *Qualitative Analysis*—Recitations, 2 hrs.; Laboratory Practice, 20 hrs.; Blowpipe practice and Determinative Mineralogy, 3 hrs. *German*—3 hrs. *French*—3 hrs.

SECOND TERM:—*Organic Chemistry*—Lectures and Recitations, 2 hrs. *Qualitative Analysis*—Laboratory Practice, 20 hrs.; Recitations, 2 hrs. *Mineralogy*—Blowpipe Analysis and determination of species, 3 hrs.; Lectures in Crystallography and Descriptive Mineralogy, 2 hrs. *French*—3 hrs. *German*, 3 hrs.

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SENIOR Y

FIRST TERM:—*Theoretical Chemistry*—Recı
ural Chemistry—Recitations (optional).
weeks, 20 hrs. *Organic Chemistry*—Exp
of the term, 20 hrs. *Geology*—Dana's, F
2 hrs. *French*—3 hrs.

SECOND TERM:—*Theoretical Chemistry*—co
hrs. *Analytical Chemistry*—Analysis of
hrs. *Assaying*—(optional). *Metallurgy*—I
3 hrs. *Mineralogy*—(optional). *French*—
The Laboratory Practice of the second te
to such special branches of Analytical or
desire, or to original investigations in conne

(b.) IN CIVIL EN

JUNIOR Y

FIRST TERM:—*Mathematics*—Analytical
ments of the Theory of Functions; Diffe
Geometry and Analysis; solution of Nume
Field work, 16 hrs. till November. *Drawin*
November. *German*—3 hrs. *French*—3 h

SECOND TERM:—*Mathematics*—Integral
try; Rational Mechanics; 6 hrs. *Drawin*
Topographical; Practice in working drawi
ical and Rail Road curves, 16 hrs. *Germa*

SENIOR Y

FIRST TERM:—*Field Engineering*—Locati
slope stakes, calculation of earth work; L
work; Henck's Field Book; 20 hrs. till No
ics applied to Engineering; Resistance of
Cutting with Graphical Problems; 8 hrs.
Blowpipe Analysis and Determinative Mine

SECOND TERM:—*Civil Engineering*—Brid
Stability of Arches and Walls; Foundation
Mechanism; Thermodynamics; Steam Engi
and Hydraulic Motors, 3 hrs. *Drawing*—D
fications and Estimates; 12 hrs. *Astrono*
work, 6 hrs. *Mineralogy*—continued durin
3 hrs. *French*—3 hrs. during Winter half-t

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(c.) IN MECHANICAL ENGINEERING:

JUNIOR YEAR:

FIRST TERM:—*Mathematics*—Analytical Geometry of Three Dimensions; Elements of the Theory of Functions; Differential Calculus, with applications to Geometry and Analysis; Solution of Numerical Equations; 6 hrs. *Surveying*—Theory and Practice; 3 hrs. until November 1st. *Principles of Mechanism*—Kinematics; 1 hr. *Shop Visiting*—Study of Machine Details and Tools; 3 hrs., beginning when Surveying ends. *Drawing*—Descriptive Geometry, 3 hrs. *German*—3 hrs. *French*—3 hrs.

SECOND TERM:—*Mathematics*—Integral Calculus, with applications to Geometry; Rational Mechanics; 6 hrs. *Principles of Mechanism*—Applied Kinematics; Forms of Teeth of Wheels; Cams; Parallel Motions; Transmission of Power by Belts and Gearing, etc.; 1 hr. until Spring recess, then 2 hrs. *Shop Visiting*—Continued, 3 hrs., until Spring recess. *Study of the Steam Engine*—2 hrs. after Spring recess. *Drawing*—Perspective and Shadows; Machine Elements; 3 hrs. *German*—3 hrs. *French*—3 hrs.

SENIOR YEAR:

FIRST TERM:—*Applied Mechanics*—Friction; Moment of Inertia; Centrifugal Force; Elasticity and Strength of Materials; Theory of Flexure and Torsion; Strains in Structures; Construction of Roofs and Bridges; Equilibrium and Pressure of Fluids; Theory of Flotation; Flow of Fluids in Pipes and Channels; Resistance of Ships; 9 hrs. *Machine Designing*—Practical Exercises in Designing Machine Details and Simple Machines, 12 hrs. *Study of the Steam Engine*—continued, 2 hrs. *Visits of Inspection*—Examination of Machinery in operation; Reports of Visits. *French*—3 hrs.

SECOND TERM:—*Applied Mechanics*—continued; Hydrodynamics; Theory of Water-Wheels and Turbines; 6 hrs. *Thermodynamics*—3 hrs. *Study of the Steam Boiler*—2 hrs. *Machine Designing*—continued; Advanced Exercises in Preparing Designs and Working Drawings for Machinery; Estimates of Weight and Cost of Machinery; 12 hrs. *French*—3 hrs., during Winter half-term. *Thesis. Visits of Inspection and Reports.*

(d.) IN AGRICULTURE:

JUNIOR YEAR:

The course is identical with that in Chemistry, except that in the Spring half-term Botany is substituted for Mineralogy.

SENIOR YEAR:

FIRST TERM:—*Agriculture*—Recitations, 2 hrs. *Agricultural Chemistry*—Recitations, 2 hrs. *Geology*—Recitations, 3 hrs. *Zoology*—Lectures, 2 hrs. *Meteorology*—Lectures, 2 hrs. *Botany*—Laboratory Practice, 5 hrs. *English*—Recitations, 2 hrs. *French*—Recitations, 3 hrs.

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SECOND TERM:--*Agriculture*—Recitations or Lectures, 2 hrs. *Agricultural Chemistry*—Recitations, 2 hrs. *Physiology*—Recitations or Lectures, 2 hrs. *Geology*—Recitations, 3 hrs. *Zoology*—continued, 2 hrs. *English*—Recitations, 3 hrs. *Heredity and Stock-Breeding*—Lectures, 2 hrs. during Winter half-term. *Sanitary Science and Public Health*—Lectures, 2 hrs. during Spring half-term. *French*—3 hrs. during Winter half-term.

(e.) IN NATURAL HISTORY:

Either Mineralogy, Zoology, or Botany, may be made the principal laboratory study, some attention in each case being directed to the other branches of Natural History.

JUNIOR YEAR:

FIRST TERM: — *Organic Chemistry*—Lectures and Recitations. *Qualitative Analysis*—Fresenius's; Laboratory Practice; Recitations. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy, 3 hrs. *Botany*—Gray's Manual, 3 hrs.; Laboratory Practice, 3 hrs. *German*—3 hrs. *French*—3 hrs.

SECOND TERM:—*Zoology*—Laboratory Practice, 6 to 12 hrs.; Recitations; Excursions (land and marine). *Botany*—Lectures; Laboratory Practice in the identification of Phaenogamous Plants, 2 hrs. *Physiology*—Huxley's. *Embryology*—Lectures. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy, 3 hrs. Lectures in Crystallography and Descriptive Mineralogy, 2 hrs. *Physical Geography*. *German*—3 hrs. *French*—3 hrs.

SENIOR YEAR:

FIRST TERM:—*Geology*—Dana's, 3 hrs.; Excursions. *Zoology* — Laboratory Practice, 8 to 12 hrs.; Lectures, 2 hrs.; Recitations, 2 hrs.; Excursions. *Botany* —Laboratory Practice in the Preparation and Examination of Microscopical Specimens, illustrative of Stem-structure and of the Anatomy of the higher Cryptogamous Plants, 5 hrs.; Excursions. *Meteorology*—Lectures, 2 hrs. *French*—3 hrs.

SECOND TERM:—*Geology*—Dana's, 3 hrs. *Anatomy of Vertebrates*—Huxley's. 2 hrs. *Zoology*—Laboratory Practice, 8 to 12 hrs.; Recitations, 2 hrs.; Lectures, 2 hrs. *Botany*—Herbarium Studies, especially in the Cryptogamous Orders; Botanical Literature; Essays in Descriptive Botany. *Sanitary Science, Laws of Heredity*, and *Principles of Breeding*—Lectures. *French*—3 hrs. during Winter half-term.

Besides the regular courses of recitations and lectures on structural and systematic Zoology and Botany, and on special subjects, students are taught in the laboratories to prepare, arrange, and identify collections, to make dissections, to pursue investigations, and when sufficiently advanced, to describe genera and species in the language of science. For these purposes, large collections in Zoology belonging to the College are available, as are also the private botanical collections of Professor Eaton.

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(f.) IN BIOLOGY PREPARATORY TO MEDICAL STUDIES:

JUNIOR YEAR:

FIRST TERM:—*Organic Chemistry*—Lectures and Recitations. 2 hrs. *Qualitative Analysis*—Fresenius's; Laboratory Practice, 20 hrs.; Recitations, 2 hrs. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy, 3 hrs. *German*—3 hrs. *French*—3 hrs.

SECOND TERM:—*Anatomy and Histology*—Laboratory Practice, 15 hrs.; Lectures and Recitations, 1 hr. *Physiology*—Huxley's; Recitations, 2 hrs. *Embryology*—8 Lectures during the term. *Organic Chemistry*—continued, 2 hrs. *Mineralogy*—continued through Winter half-term, 3 hrs. *Botany*—Lectures; Laboratory Practice in the identification of Phænogamous plants, 5 hrs. during Spring half-term; Excursions. *German*—3 hrs. *French*—3 hrs.

SENIOR YEAR:

FIRST TERM:—*Physiological Chemistry*—Recitations and Lectures, 3 hrs.; Laboratory Practice, 13 hrs. *Theoretical Chemistry*—Lectures and Recitations, 2 hrs. *Zoology*—Lectures, 2 hrs. *Botany*—Laboratory Practice in the preparation and examination of microscopical specimens, illustrative of stem-structure, and of the anatomy of the higher cryptogamous plants, 5 hrs. *Geology*—Dana's, 3 hrs. *French*—3 hrs.

SECOND TERM:—*Physiological Chemistry* and *Experimental Toxicology*—Illustrative Lectures, Recitations, and Laboratory Practice, 27 hrs. *Geology*—Dana's, 3 hrs. *Zoology*—continued, 2 hrs. during Winter half-term. *Sanitary Science*—Lectures, 2 hrs. during Spring half-term. *Laws of Heredity and Principles of Breeding*—Lectures, 2 hrs. during Spring half-term. *French*—3 hrs. during Winter half-term.

(g.) IN STUDIES PREPARATORY TO MINING AND METALLURGY:

Young men desiring to become Mining Engineers can pursue the regular Course in Civil or Mechanical Engineering, and at its close can spend a fourth year in the study of Metallurgical Chemistry, Mineralogy, etc.

(h.) IN THE SELECT STUDIES PREPARATORY TO OTHER HIGHER STUDIES:

JUNIOR YEAR:

FIRST TERM:—*Mineralogy*—Blowpipe Analysis and Determinative Mineralogy, 2 and 3 hrs. *Astronomy*—Recitations, 4 hrs. *English*—Early English, 2 hrs. *History*—Green's Short History of the English People, 2 hrs. *French*—3 hrs. *German*—3 hrs.

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SECOND TERM:—*Mineralogy*—Lectures; Laboratory work, 3 hrs. during Winter half-term. *Astronomy*—4 hrs. *Botany*—Lectures; Laboratory Practice in the identification of Phænogamous Plants, 2 hrs. during Spring half-term. *Physical Geography*—4 hrs. during Winter half-term; Recitations from Guyot and Lectures. *English*—Chaucer, Bacon, Shakspere, 2 hrs. during Winter half-term. 3 hrs. during Spring half-term. *History*—Green's History, continued, 2 hrs. during Winter half-term, 4 hrs. during Spring half-term. *German*—3 hrs. *French*—3 hrs.

SENIOR YEAR:

FIRST TERM:—*Geology*—Recitations. 3 hrs.; Excursions. *Zoology*—Lectures, 2 hrs. *Linguistics*—Whitney's Life and Growth of Language, 2 hrs. *English*—Shakspere, 2 hrs. *Meteorology*—Lectures, 2 hrs. *Political Economy*—Mill's Principles. 4 hrs. *French*—3 hrs.

SECOND TERM:—*Geology*—continued, 3 hrs. *Zoology*—continued, 2 hrs., during Winter half-term. *Meteorology*—Lectures, 2 hrs. during Winter half-term. *Sanitary Science*—Lectures, 2 hrs. during Spring half-term. *Political Economy*—Mill, continued; Exercises; 3 hrs. during Winter half-term. *Constitutional Law*—6 hrs. during Spring half-term. *English*—Shakspere, Milton, Dryden, Pope, Gray, and later authors, 3 hrs. *French*—3 hrs., during Winter half-term.

Exercises in English Composition are required during the entire course from all the students. The preparation of graduating theses is among the duties of the Senior year.

Lectures on Military Science and Tactics are annually given by officers of the United States Army.

The following account of the various subjects specified in the above scheme will explain the character and aim of the instruction.

ELEMENTARY CHEMISTRY.—The exercises in Elementary Chemistry consist in recitations from a text-book and experiments by the students in the laboratory to illustrate statements in the book. The object of the laboratory work is to facilitate the study of the subject, to train the students in manipulation and in the observation of chemical phenomena. Notes are required and students are questioned on the experiments. As the class is divided according to scholarship in Chemistry and Physics, opportunity is given to those who are most proficient to make rapid progress.

ANALYTICAL CHEMISTRY.—*Qualitative and Quantitative.*—This study is intended to serve two purposes. Analytical Chemistry is used by the advanced student as a means of investigation in scientific or technical researches. The beginner, however, derives from its study advantages of another kind. The knowledge of the properties of chemical compounds, and familiarity with chemical reactions gained by experience in the laboratory, and the development of the reasoning faculties by the application of this knowledge in analytical processes, enables the student to generalize and classify chemical phenomena and aids him to understand

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the more abstract theories of chemical philosophy. The method of instruction adopted is conformed to this view of the uses of the study. Text-books are used and recitations are required, but the more important part of both study and instruction is performed in the laboratory. In order to solve the problems which are there constantly presented, the student, aided by books and instructors, must learn both principles and their applications. The student throughout his course in Analytical Chemistry, spends four consecutive hours in laboratory work during five days of the week. The laboratory, however, is kept open seven hours daily for the benefit of graduate students and others who desire to devote more time to this study.

Qualitative Analysis forms a part or the courses in Chemistry, Biology, Agriculture and Natural History. Quantitative Analysis is one of the more important studies of the Senior year in the Chemical course. It is also included to some extent in the Agricultural Classes.

ORGANIC CHEMISTRY is taught by informal lectures and experimental illustrations as well as by text-book drill, a lesson from Richter's Organic Chemistry being given out for each instruction-hour. The class has two exercises weekly throughout the year. The course is adapted to give a fairly complete outline of the subject and some familiarity with the more important bodies and classes of bodies.

In addition to this, the Senior students in the Chemical Course are required to spend 20 hours per week during the latter half of the first term in experimental work in Organic Chemistry. This is intended to supplement the preceding course and at the same time to serve as a preliminary training for such students as desire to made a special study of Organic Chemistry.

Opportunity is also afforded for the carrying on of original investigations in this subject, either in connection with theses or as a part of the regular work in the case of advanced students.

PHYSIOLOGICAL CHEMISTRY and EXPERIMENTAL TOXICOLOGY.—Physiological Chemistry is taught by laboratory exercises, illustrative lectures and recitations. Each student is provided with a suitable working place in the laboratory, well equipped with all needed apparatus and material. The regular course of work, designed especially for Senior students in the Biological Course, extends throughout one year and embraces a thorough study of the chemical composition of the various tissues and fluids of the body, together with a study of the chemical and physiological processes of respiration, digestion, secretion, excretion, and nutrition in general.

Beginning with a study of the albuminous bodies, the experimental work extends through the epithelial, connective, contractile, and nerve tissues. Proceeding then to digestion, the various digestive fluids are studied, artificial digestions are made, and the several products of digestive action isolated and studied. The blood and urine are next considered, and students are taught to make both qualitative and quantitative analyses of the latter and to identify abnormal constituents. A portion of one term is also devoted to a study of the chemical reactions of the more important mineral and organic poisons, and their physiological action determined experimentally. Students are also taught how to separate poisons from organic tissues and fluids, and to identify them both by chemical and physiological

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reaction. During the latter half of the second term, Senior year, opportunity is afforded for the carrying on of original investigations on some selected subject in either physiological chemistry or toxicology, in connection with the preparation of graduating theses. The course of work is particularly recommended to students intending to enter upon a course of medical studies.

ANATOMY AND ELEMENTARY PHYSIOLOGY.—The object sought in the instruction in Anatomy and Physiology, as taught during Junior year, is the manual and mental training of the student in the methods of investigation by which the facts and principles of these sciences have been established, and at the same time to give him a sufficient knowledge of their elements to enable him to pursue with profit the special studies of the Biological Course as a preparation for medical studies. With this end in view, four forenoons each week are given to laboratory work in Anatomy and Histology. The student, under the immediate supervision of the instructor, dissects specimens of a number of different animals, and is required to make careful sketches and records of his work; he also examines the different animal tissues with the microscope, makes microscopical preparations and is taught the methods of anatomical and histological investigation. This work is reviewed each week by means of text-book and recitation or lecture and examination. The elements of Human Physiology are taught by text-book, recitations and demonstrations. The physiology of digestion and nutrition is taught during Senior year in connection with Physiological Chemistry. During the last part of the term there is a short course of lectures on Embryology with special reference to Human Morphology.

GEOLOGY.—The course in Geology includes recitations and oral instruction extending through the entire year on alternate mornings. During the first half-year, the recitations are attended by the entire Senior Class, except those in the course in Mechanical Engineering. This part of the course includes Physical, Lithological, and Dynamical Geology. These subjects are illustrated by diagrams and specimens. During the first term each student is required to make a collection containing a specified number of the most important rocks and minerals, and to pass a thorough examination upon them at the end of the first term; the object is to compel every student to become personally familiar with the appearance as well as with the composition and other characters of the rocks and minerals that are of most importance in Geology, as well as in the arts.

The last half of the year is devoted to Historical Geology and Palæontology. This part of the course is pursued by all the Seniors except those in the courses in Mechanical and Civil Engineering. Suitable collections of fossils are used to illustrate the subject.

Opportunities are afforded for optional geological excursions during the warmer months.

MINERALOGY.—The instruction in Mineralogy is carried on by means of practical work in a laboratory especially fitted up for the purpose, and is intended to familiarize the student with the common minerals; attention being devoted especially to those which are of economic, geological, or scientific importance. To understand better the chemistry of the subject, the student is first made familiar with the simple chemical and blow-pipe reactions useful in testing minerals, and later applies this knowledge to the determination of unknown species. The

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students have access to a labeled collection where they can study the properties of the minerals and make comparisons, and also to extensive unlabeled collections, especially arranged to give them practice and facility in the correct identification of minerals. In addition to the laboratory work, instruction is given in Crystallography, illustrated by a collection of models and natural crystals. The lectures in Descriptive Mineralogy to the more advanced students are illustrated by means of the extensive private collection of Professor Brush. The laboratory is provided with apparatus for the thorough chemical or physical investigation of minerals and with an extensive library to which the students have access. The laboratory is open seven hours each day to accommodate any who desire to devote more time and attention to the subject than is laid out in any of the prescribed courses.

ZOOLOGY.—The course in Zoology includes a course of lectures on Systematic Zoology, Morphology, and Embryology, which are attended by all the Seniors except those in the courses in Mechanical and Civil Engineering. These lectures are generally given twice a week, and continue during about half the year. The students are required to keep careful notes of the lectures.

Students in the Natural History Course are also required to pursue a course of laboratory instruction during the second term of the Junior and all of the Senior year. This generally occupies two to four hours a day on four days of each week. It includes dissections of various classes and orders of animals, with microscopic studies of the finer structures and of minute animal forms, as well as work in Systematic Zoology.

Special courses of recitations or lectures on particular subjects are also given when desirable.

BOTANY.—The scheme of instruction provides for three successive courses of study, as either ending the study for the ordinary student, or introducing it for one who desires to become a professional botanist.

The first or elementary course, which is required of all the Freshmen, is designed to teach the nature of the visible organs of flowering plants. tracing the life-history of vegetation from seed, through stem and root, leaves, branches, buds, blossoms and fruit, to seed again. The method consists mainly in the use of some easy text-book, like Gray's Lessons, with whatever illustrations and explanations may be needed to secure the student's attention. The second course, coming the next year, is restricted to the sections in Biology, Natural History, Agriculture, and select studies, and is intended to enable the student to recognize the chief natural orders of native plants, with the ability to identify the common species. The class meets two or three times a week in spring and summer, and is practiced in identifying plants, using Gray's Manual as a standard, and employing the ordinary simple dissecting microscope. At this point the instruction for the Select Course ceases; in the next fall term the work for the Courses in Biology, Natural History, and Agriculture is entirely practical, books being used only for reference. Students begin with cutting thin sections of some common woody and herbaceous stems, and are shown how to prepare such sections for examination and for permanent preservation as microscopic objects. After acquiring some facility in microscopical manipulation, various parts of flowering plants are brought in for dissection and examination, and towards the close of the term some attention is given to Ferns, Mosses and Algæ. This

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finishes the course for ordinary students; for those who may desire to prosecute the science professionally, the work is arranged to suit individual requirement, whether it be in the direction of Histology, or of Systematic Botany as applied to flowering plants, or to Ferns, Mosses, Hepatics, or Algæ.

AGRICULTURE.—Instruction in the course in Agriculture is by recitations, lectures, and laboratory work, with such aids and appliances as are suited to the class room, and such excursions as are practicable.

More attention is naturally given to Chemistry than to the other sciences, it being studied during nearly the whole course. First elementary and general chemistry, then analytical, organic, and agricultural chemistry, the latter including the chemistry of the soil with the theory of manures, and the nutrition of crops and animals.

The special instruction in agriculture includes a study of tillage, draining and irrigation; the cultivation, care and preparation of the staple crops of the country, the diseases of plants, the rotation of crops, planting and forest culture; the laws of heredity and principles of stock-breeding, the production of live stock and animal products; the marketing of produce, special and mixed farming, systems of land tenure and systems of husbandry.

For the methods of instruction in mathematics, physics, mineralogy, botany, zoology, physiology, and the modern languages, see those topics respectively.

SANITARY SCIENCE.—The lectures on this subject discuss the natural laws which govern the public health; their relation to the social habits and condition of communities; instruction in the use of mortuary statistics; epidemics and pestilences, with their relations to the property of a community, and methods of control; the germ theory of disease and theory of disinfectants; the hygiene of private dwellings and public buildings; the relations of public health to water supply and to sanitary engineering; legislation relating to the public health, and the methods of official sanitary administration.

MATHEMATICS.—The Mathematical studies of the Freshman Year are pursued by all the members of the class; those of the Junior Year by students in the courses of Engineering and properly qualified Special Students who may choose them. During the latter year, in connection with the instruction briefly indicated in the scheme above [p. 47], a course of familiar lectures is given to supplement the ordinary class-room exercises.

PHYSICS.—The object of the experimental lectures is not only to elucidate the subjects treated in the text-books employed, but also to extend the treatment of such subjects, and to introduce others where thought desirable. A considerable portion of the work of the year is the preparation for recitation on matter thus presented.

At the end of November the Freshman class is re-divided into three sections, according to capacity shown in the subjects of Chemistry and Physics. After this, although the experimental lectures will be attended as before by the class as a whole, the higher divisions will be able to pursue the studies more thoroughly.

The facilities of the Physical Laboratory will be extended to such graduate students and Seniors as may desire them.

Course in Advanced Physics.—A course of two lectures per week, beginning in January, supplemented by laboratory work. The earlier portion of the time is

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devoted to the theory of observation and the method of least squares. The course is optional to all who have a command of the calculus.

CIVIL ENGINEERING.—The object of this course is to give a thorough preparation, first of all, in the principles of the various sciences involved, and afterwards, as extensive practice in the application of these principles as the time at disposal, the ability of the students, and the facilities and plant permit.

Under the first head are included such subjects as Mathematics, Physics, Mechanics, Thermodynamics, Astronomy, Geology, Mineralogy, Chemistry, and Botany; and under the second head, Drawing, Surveying, Strength and Properties of Materials, and Design and Construction of various kinds, such as Bridges, Roofs, Foundations, Arches, Retaining Walls, Dams, Water Works, Railroads, Improvement of Rivers and Harbors, Sewerage and Drainage, Water Motors, etc.

The one division includes Civil Engineering as a Science, the other Civil Engineering as an Art. The ground covered by the first is definite, and the instruction is made as thorough as possible. The ground covered by the second is of almost indefinite extent. Here, by a careful selection of practical examples, such as occur in engineering practice, the application of principles is illustrated, and together with the analytical or algebraic methods, the student is also instructed in practical graphic solutions wherever such solutions present a special value. Much time is devoted to geodetic operations and to surveying in the field. Instruction is given in the practical operations connected with the reconnaissance, location, and surveys of roads, canals and railroads, such as setting out, cross-sectioning, setting grade stakes, calculation of earth work, etc. Thorough instruction is given in drawing and design, the construction of working drawings and principles of designing as applied to bridges, roofs, etc.

The instruction is by means of practical exercises, lectures, and recitations, so combined as to develop as far as possible the mental powers of the student. Visits of inspection are made at suitable intervals to private and public works of engineering interests.

The entire course requires five years, three years of undergraduate and two of graduate instruction; and a Thesis of merit upon some approved subject, accompanied by designs and estimates, is required upon the completion of the course, as also at the end of the first three years. Examinations are also held at the end of every term and year.

In what follows, such details are given as may be of interest to those who contemplate taking the course:

Mathematics—6 hours weekly, Junior Year, both terms. See Synopsis of Course.

French and German—Students in this course take in the Junior Year the regular studies of the Junior Class in both German and French, 3 hours each. In the Senior Year, French is continued, 3 hours, during the Winter half-term.

Drawing and Descriptive Geometry—Drawing is begun at once in the first term of Freshman Year, under the charge of the Street Professor of Drawing in the Art School, and includes practice in free hand drawing. In the second term, under the Instructor in Instrumental Drawing, the students take isometric drawing with application to drawing from models and structures by measurement, shading, tinting, conventional use of colors, principles of orthographic projections, and practice in making simple working drawings, 3 hours both terms.

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The Drawing of Junior Year, 3 hours, both terms, includes Descriptive Geometry, the drawing of structures from measurement, and elements of design for simple structures. The instruction is by recitations, lectures, practical exercises and models, and is under the charge of the Instructor in Instrumental Drawing and the Professor and Instructor in Civil Engineering. Included in the work of this year is also the mapping of surveying field notes.

In the Senior Year, the drawing consists of the mapping of the surveys of that year, and the designing of structures and finished drawings, designs and estimates, under the charge of the Professor and Instructor in Civil Engineering, 6 hours both terms.

Surveying and Field Engineering—The instruction in the field occupies about 20 hours for six or more weeks in both terms of Junior and Senior Year. The exercises at these times are so arranged as to secure as much consecutive time as possible in the field. In Junior Year the use and adjustments of the instruments are learned and practice surveys made, together with recitations and lectures upon surveying operations and methods of keeping field notes. Levels are run, surveys made, plotted and checked; blue print copies of drawings made, the use of compass, level and transit acquitted. In the second term of Junior Year land and topographical surveys are made and railroad curves run.

In the first term of Senior Year a line of railroad is located and set out from a contour map previously obtained, grades and curves established and set out, and computations made. The theory of the economic location is taught by lectures and recitations in connection with the field work. The work is arranged so that each student has sufficient practice in all the various operations. The text-books used are Gillespie and Johnson's works, Henck's Field Book, Gore's Elements of Geodesy, and Merriman's Theory of Least Squares. The course is under the charge of the Professor and Instructor in Civil Engineering, aided by several assistants.

Mechanics of Engineering—Senior Year, 6 to 8 hours, both terms. The text-books of Weisbach, 1st and 2d volumes, are used in connection with lectures and solution of practical problems in illustration of the various topics. The course includes thorough instruction in the strength of materials, the stability of foundations, retaining walls, dams and embankments, and masonry arches, by lectures and graphic methods. Questions of hydraulics, water supply, and measurement of discharge, receive attention, and the theory and construction of water motors. A course in Thermodynamics with application to air and steam engine is also included.

Construction and Design—Senior Year, 6 hours both terms. A thorough course is given in the determination of stresses and the detailed design of roofs, bridges, etc., with working drawings, specifications and estimates. Visits of inspection are made, and recitations and lectures held in connection with the work in the drawing room.

Astronomy—A course is given under the charge of the Professor in Astronomy, 6 hours, second term of Senior Year, including practical work and the use of the sextant and transit in determining time, latitude, and azimuth.

Geology—This course occupies 3 hours, up to the middle of the second term of Senior Year.

Mineralogy—This course, under the Instructor in Mineralogy, occupies 3 hours up to the middle of the second term in Senior Year.

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A course of lectures on the theory of electricity and its applications, by the Professor of Physics, is open to students in this Department, and can be taken as a part of the preparation for a graduate course in the higher branches of electrical science.

MECHANICAL ENGINEERING.—The objects aimed at in the plan of instruction in this course are, to give to the students a thorough training in elementary and advanced Mathematics and Physics, and their application to the Science of Construction; to make him familiar with the general principles of Engineering and with the practical details of mechanical construction through which these principles are made useful; and to enable him ultimately in beginning the work of his profession to bring to bear upon it a well balanced store of theoretical and practical knowledge, and a mind trained in correct habits of thought and work.

The complete course covers five years, three of which are spent in undergraduate study and two in a graduate course, a portion of which may be spent in actual practical work. The subjects and methods of instruction in the undergraduate course are as follows:—

Mathematics—See synopsis, page 54.

French and German—Students take in the Junior year the regular studies of the Junior Class in both French and German. In the Senior year, French is continued during the Winter half-term.

Surveying—A short course in Surveying comprises lectures on methods of surveying and the construction and use of instruments, also practice in field work in the use of the level and transit, City surveying. establishing grades, and laying out buildings.

Shop Visiting divides the time equally with Drawing in the Junior year until the Spring Recess. The student, accompanied by the instructor, is employed in studying machinery in use and in process of construction in different machine shops in the city. He is required to make satisfactory, carefully dimensioned sketches, from measurements taken by himself, of the complete machines and their parts, and to describe the tools and mechanical operations used in producing the simpler pieces.

Drawing—Descriptive Geometry is taught in the drawing room by lectures and recitations, and by exercises at the drawing board where the problems are solved graphically by the student. Instruction in *drawing Machine Elements* is given in the Junior year. Models and cartoons showing examples of approved practice are used by the instructor, who also gives personal attention to each student's work at the board as it progresses.

Principles of Mechanism—This is a course of theoretical and applied Kinematics. Instruction is by text-book and lectures illustrated by diagrams and models, an extensive collection of which belongs to the School and is accessible to the student.

Steam Engine—Recitations and lectures in this object begin in the Junior year, after the Spring Recess. They relate to the structural details of engines and to the mechanical principles involved in their working. The subject is continued in the first term of Senior year, when particular attention is directed to various kinds of valve gear, the governor, the fly-wheel, balancing, and the effect of the weight of the reciprocating parts. In the second term of Senior year, the study of *Steam Boilers* takes the place of Engines.

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Indicator Practice—In the Senior year the student is afforded opportunities to apply the indicator to various engines in operation, and has practice in reading indicator cards and measuring them by the planimeter. He is taught to detect such defects in the engine as are shown by the cards.

Applied Mechanics—In the course lectures, recitations, and exercises in the solution of practical problems, relate to the topics specified under this head in scheme on page 47.

Thermo-dynamics—Recitations and lectures on the mechanical theory of heat and its applications to hot-air engines, gas engines, and the steam engine.

Machine Design—The course in this subject consists chiefly in practical exercises at the drawing board, and partly in lectures on the functions of machines and the mechanical principles which are applied in determining the proportions of machinery. The student, under the guidance of an experienced instructor, is employed in making complete working drawings of machines, many examples of which are in the drawing rooms and the basement of the School. He does not copy the examples, but is required to change the dimensions and in many cases to alter the design, and is ultimately taught to make partly new designs of important machinery, such as cranes, yacht engines, machine tools, boilers, etc. The discipline the student receives is such as he would obtain in the drawing office of an engineering establishment, while he is also carefully instructed in the theory of the subjects he deals with, and in the practical bearing of all his work.

In the Senior year several excursions are made by the class, accompanied by one or more instructors, to neighboring manufacturing and engineering centers, where large manufactories, pumping works, ocean steamers, etc., are visited. Full notes must be taken, and a satisfactory written report upon the machinery examined, is required of the student.

Thesis—Before graduating, the student must present a satisfactory thesis on some subject approved by the professor in charge of the department of Mechanical Engineering.

A course of lectures on the theory of Electricity and its applications is open to students in this department, and these lectures can be taken as a part of the preparation for a graduate course in the higher branches of electrical science.

ASTRONOMY—Students in the Select Course receive instruction in Astronomy during Junior year, first term, four hours per week.

Students of Civil Engineering during the second term of their Senior year have six recitations per week, and also practical experience in the determinations of time, azimuths, latitude, and longitude, etc.

ENGLISH—The course is designed to give the student acquaintance with the great representative writers of the various epochs. A history of the language is one of the studies of the Freshman year; and after that year the study of the language is made entirely subordinate to that of the literature. During the first term of Junior year, however, extracts from Early English authors are read, and Early English grammar studied, so as to familiarize the student with the inflections then in use, and the distinctions existing between the leading dialects. It is the aim of the term's work to give such knowledge of forms, and to some extent of words, that the student will be able to read at sight any English author whose writings do not involve special difficulties of language or vocabulary.

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With the second term the regular study of English literature proper begins with Chaucer; and for the rest of the course till the end of Senior year the following authors are read: Bacon, Shakespere, Milton, Dryden, Pope, Gray, Goldsmith, and later writers. Those mentioned in the list are always studied, but other authors not named are also taken up, the course varying somewhat in different years. In all cases complete works of a writer are studied, not extracts; as for instance several of Chaucer's Tales, and several of the plays of Shakespere. The authors are taken up in chronological order, and the literary history of the time is likewise carried on in connection with the great representative writers of each period.

GERMAN—The aim in this department is to give such a knowledge of facts and principles as shall qualify the student as rapidly as possible to use the language for such various purposes as his special needs may require, and particularly to facilitate the use of German treatises in his later special studies. To accomplish this, the course consists of the combination of the study of systematic German grammar with a complementary and progressive course of oral translation from English into German, the latter being designed for the double purpose of increasing the command of grammatical principles, and through the establishment of a habit of ready and accurate expression, of laying the foundation for future colloquial use of the language. In connection with the foregoing, it is attempted to introduce the student to as many different styles and as many forms of composition as the time allows. For this purpose the reading matter is in general selected from readers and collections prepared for the use of schools in Germany, and characterized by the number and variety of their extracts, thus enabling the instructor to select pieces that illustrate one another and to avoid similar lines of reading with successive classes. Constant attention is paid during a portion of the course to English affinities, to analogies in the formation of English and German abstract terms, to the commoner rhetorical resemblances and differences, to the details of arrangement in German sentences, and the development of secondary from primary significations of words.

In view of the shortness of the course there is no attempt to secure any considerable acquaintance with German literature. A body of representative pieces of lyric poetry, however, is made the basis of careful literary study, with special attention to poetic diction and variety of metrical form. Memorizing German poems is practiced to some extent as a class exercise, as also retranslation of dictated literal versions of simple pieces into German verse, in accordance with prescribed rhythm and sequence of rhyme.

Occasionally, when the proficiency of a class allows it, an advanced division is organized, which is thus enabled to read a much larger amount of matter and to pursue more critical methods. The attention of such a division is sometimes given for a few months to extracts treating leading events of German history, with a collateral course of German historical poetry, the selections being made so as to be mutually illustrative. Historical poems not contained in the text-book are often furnished by dictation.

During the last few weeks of the course, there is an attempt to initiate the student into the art of rapid and intelligent, though uncritical reading, dispensing largely with dictionary and grammar and aiming to form independent habits of observation and induction. For this purpose recourse is had to entertaining novels.

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In general, it is the endeavor, while aiming p
ing a working knowledge of contemporary Ger
and empirical methods, to enforce correct notic
secure incidentally some of the most important
linguistic study, and to give some conception,
ional statements, of the various special direct
advanced course would necessarily take.

The time allotted to the subject is three hour
Junior years. In the Senior year no instruct
year, there is a prize examination on some su
viously. The subject for the present year is G

Regular text-books: Whitney's German Gra
ary; Ahn's Exercises, or Eysenbach's Germ
books: Lebensbilder, III and IV; Geerling's
gel, Lesebuch, III; Daniel, Lehrbuch der Geog
historical maps; Andrä, Erzählungen aus de
Auswahl deutscher Gedichte; Wendt, Sammlu

FRENCH—To avoid repetition, it will suffice t
is pursued in French as above detailed for Ger
three weekly exercises extend through the ent
year, and are based on a systematic review of
in Whitney's French Grammar, supplemented b
One of the leading objects being to further th
treatises, a wide extent of reading is insisted on
such as "Le Conscrit," "L'Ami Fritz," "La Pe
of diversified vocabulary by which at last sight
appropriate to the department may be profitab
conversational course runs along parallel with
language.

HISTORY—The principal part of the work co
History of the English People being used as a
required to look up special topics, and to give t
class; the books used for this purpose are drav
in the class-room. The location of places is en
which the students are required to fill in. Pa
history of institutions and to the constitutional
try.

POLITICAL ECONOMY.—In the beginning of
familiarize the students with the fundamental
particularly to train them in economic reasor
then taken up and discussed, and special topics
vestigation. A small library has been provid
copies of each of the principal authorities, in or
to familiarize themselves somewhat with the li
pense to themselves.

DRAWING.—The course in drawing extends
the first term of Freshman year, the students

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Art School building, under the direction of Professor Niemeyer, of the Yale School of the Fine Arts. After the completion of the course in free-hand drawing, instruction is given by Mr. F. R. Honey, during the second term, in the elementary principles of instrumental drawing, embracing Elementary projection drawing, Isometric drawing, and Descriptive Geometry as far as warped Surfaces. This course is obligatory upon all.

During the Junior and Senior years, instruction in drawing is obligatory only on the students in Civil and Mathematical Engineering. In the former year the system of instruction embraces shades and shadows, tinting, perspective, and warped surfaces. By this method all the problems in Descriptive Geometry are required to be worked out on the drawing-board instead of the black-board. The course extends through the entire year, and is under the direction of Mr. Honey.

VII.

TUITION CHARGES.

The charge for tuition for undergraduate students is $150 per year, payable $55 at the beginning of the first and second terms, and $40 at the middle of the second term. An additional charge of $5 a year is made to each student for the use of the College Reading Room and Gymnasium, which is payable at the beginning of the first term, making the total charge for that term $60. The student in the Chemical course has an additional charge of $70 per annum for chemicals and use of apparatus. He also supplies himself at his own expense with gas, flasks, crucibles, etc., the cost of which should not exceed $10 per term. A fee of $5 is charged members of the Freshman Class for chemicals and materials used in their laboratory practice, and the same fee is required from all (except Chemical students) who take practical exercises in Blowpipe Analysis and Determinative Mineralogy. A fee of $5 a term is also charged to students in the Zoological and Anatomical Laboratories, for materials and use of instruments.

For the graduate students the charge for tuition is one hundred dollars per year.

VIII.

CHURCH SITTINGS.

Free sittings for students in this department of Yale University are provided as follows: in the Center Church (Congr.); in the Trinity (Episc.); and in the First Methodist Church.

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Those who prefer to pay for a sitting for one year, more or less, in the churches above mentioned, or in any other church of any denomination, will be aided on application to the Secretary of the School.

Sittings in the Gallery of the College Chapel are free as heretofore to the students of this department.

IX.

DEGREES.

Students of this department, on the recommendation of the Governing Board, are admitted by the Corporation of Yale College to the following degrees. They are thus conferred:

1. Bachelor of Philosophy; on those who complete any of the three-years courses of study, passing all the examinations in a satisfactory manner, and presenting a graduation thesis.

The fee for graduation as Bachelor of Philosophy, including the fee for Triennial Catalogues, Commencement Dinners, etc., is $10; unless the person taking the degree is also an academical graduate, when it is but $5.

2. Civil Engineer and Dynamical Engineer: The requirements of these degrees are stated on page 41.

3. Doctor of Philosophy: The requirements of this degree are stated on page 39.

X.

TERMS AND VACATIONS.

The next academic year begins Thursday, September 22, 1887. The first term begins twelve weeks from Commencement-day and continues thirteen weeks: the second term begins regularly on the first Thursday in January and continues until Commencement-day, with a spring recess—usually of eight days—including Easter. (See Calendar, p. 24.)

XI.

ANNOUNCEMENT IN RESPECT TO STATE STUDENTS.

The scholarships established in this School in consequence of the bestowal upon it of the Congressional grants are designed to

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aid young men who are in need of pecuniary assistance in fitting themselves for agricultural and mechanical pursuits of life. All applicants must be citizens of Connecticut. In case there are more applicants than vacancies, candidates will be preferred who have lost a parent in the military or naval service of the United States, and next to these such as are most in need of pecuniary assistance; and the appointments will be distributed as far as practicable among the several counties in proportion to their population. The appointing Board for the current year, consisting of the Board of Visitors for the State and the Secretary of the School, will meet on June 28, 1887, and at or about the same time in the year 1888, due notice of which will be given by publication in every county in the State. All applications should be made previous to that time. Blank forms for application will be sent, when requested, by Professor GEORGE J. BRUSH, Secretary of the Appointing Board.

XII.

ANIVERSARY.

The Anniversary of the School is held on Tuesday of the Commencement week in Yale College, when selections from the graduation theses are publicly read. The degrees are publicly conferred by the President and Fellows of Yale College on Commencement Day.

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APPENDIX.

ENTRANCE EXAMINATION PAPERS.

The following are the papers for 1886, upon which applicants for admission were examined at the June and September examinations.

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ARITI

JUNI

1. Reduce $\frac{9240}{76440}$ to its lowes
2. Divide $8\frac{11}{32}$ by $3\frac{1}{8}$ and expl
3. Divide .0324 by 6.23 and r
4. What is the bank discoun
60 days at 6 per cent.?
5. Extract the square root of
6. A, B and C form a partner
puts in $5,000, B puts in $3,0(
they gain $3,200 what would be
7. A box is 16 inches wide, 0.
deep. Find its volume in cubic

ARITI

SEPTEM

1. Find the greatest commo
multiple of 9829 and 24570.
2. Divide $\frac{3}{7}$ of $1\frac{3}{5}$ by $\frac{1}{16}$ of $9\frac{1}{8}$
3. Divide .0003648 by 8.2 an
mal point in the quotient.
4. If 5 men can do a piece of
in how many days of 8 hours e
same rate, do an equal amount
5. For what amount, payable
to a bank discounting at 6 per c
6. Extract the square root of
7. If the pressure is uniform
inch, what would be the pressu
decimeter?

PLANE G

JUNI

[NOTE.—State at the head of your pape
subject and

1. Prove that the three perp
triangle to the opposite sides m

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2. Two parallel chords or secants intercept equal arcs on a circumference.

3. The base of a triangle and the angle opposite being given, to construct the locus of the vertex of the latter.

4. Define similar polygons. Prove that two triangles are similar when they are mutually equiangular.

5. Determine the ratio of the area of the segment of a circle whose arc is 60° to the area of the corresponding sector.

SOLID AND SPHERICAL GEOMETRY.

JUNE, 1886.

[NOTE.—State at the head of your paper what text-book you have studied on the subject and to what extent.]

1. Define a plane. When is a straight line said to be perpendicular to a plane? How is the diedral angle formed by two intersecting planes measured?

2. Prove that parallel planes intercept equal segments of parallel lines intersecting them.

3. Define a polyedral angle. When are two polyedral angles said to be equal? When symmetrical? Draw a figure representing two symmetrical polyedral angles.

4. Determine (1) the locus of all points in space equally distant from two given points; (2) the locus of all points in space at a given distance from each of the two given points.

What condition must the given distance fulfill in order that the last problem may be possible?

5. When is one spherical triangle called the polar triangle of another? Prove that if A′B′C′ is the polar triangle of ABC, then, reciprocally, ABC is the polar triangle of A′B′C′.

State an important property of two reciprocally polar triangles.

6. Define the *spherical excess* of a spherical triangle. How can you find the area of a spherical triangle when you have its spherical excess given? Illustrate your answer by a simple example

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GEOMETRY.

SEPTEMBER, 1886.

[NOTE.—State at the head of your paper what text-book you have studied on the subject and to what extent.]

1. Bisect a given angle and prove your construction.

2. Of lines passing through the end of any radius of a circle the perpendicular is a tangent to the circle and every other line is a secant.

3. If from the right angle of a right-angled triangle a perpendicular be dropped upon the hypothenuse, the square of the perpendicular will be equal to the rectangle of the two segments into which it divides the hypothenuse.

4. Explain what is meant by dividing a line harmonically and illustrate the definition.

Prove that the hypothenuse of a right-angled triangle is divided harmonically by any pair of lines through the vertex of the right angle, making equal angles with one of its sides.

5. (*a*) Of two equiangular triangles the side of the one is twice a side of the other; compare the areas of the triangles. (*b*) Compute the length of the sides and the area of an equilateral triangle inscribed in a circle and whose radius is 1.

6. Define the angle which a straight line makes with a plane. Prove that a straight line makes equal angles with parallel planes.

7. Define a parallelopiped. Prove that the opposite faces of a parallelopiped are identically equal parallelograms.

8. Define the poles of a circle of a sphere; also, a great circle of a sphere. How do any two great circles of the same sphere divide each other?

Prove that the poles of any two great circles AB, CD, of a sphere, lie on a third great circle whose poles are the points of intersection of the circles AB, CD.

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ALGEBRA TO QUADRATICS.

JUNE, 1886.

[NOTE.—State at the head of your paper what text-book you have studied on the subject and to what extent.]

1. Resolve the following expressions into factors as far as possible: $1-x^4$; $x^4y^2+2x^2y^2z^2+y^2z^4$; $x^{2m}-x^m+\frac{1}{4}$; x^3+y^3.

2. Get as simple an expression as you can for $\dfrac{2m-3+\frac{1}{m}}{\frac{2m-1}{m}}$

3. Given $\frac{ab+x}{b^2}-\frac{b^2-x}{a^2b}=\frac{x-b}{a^2}-\frac{ab-x}{b^2}$, to find the value of x.

4. Given $ax=by+\frac{a^2+b^2}{2}$ and $(a-b)x=(a+b)y$, to find x and y.

5. Given $\frac{2x+3}{2}+3x<14$ and $\frac{4x-2}{3}+2x>9$, to find the limits between which x lies.

6. (a) Expand $(1+x)^4$ by the binomial formula.

(b) Simplify $\sqrt{a^0b^{-2}}$; $\sqrt[4]{49}$; $(3\sqrt[4]{\frac{1}{9}})^2$; $\sqrt[3]{3a}\times\sqrt{2b}$; $2abc\sqrt{20}+3a\sqrt{5b^2c^2}$; $\sqrt[3]{a^2b^6c^9}$.

ALGEBRA FROM QUADRATICS.

JUNE, 1886.

[NOTE.—State at the head of your paper what text-book you have studied on the subject and to what extent.]

1. Solve the quadratic $ax^2+bx+c=0$, and point out when the roots will be real and unequal, when real and equal, and when imaginary, if numerical values be assigned to a, b and c.

2. Form a quadratic equation whose roots shall be 3 and $\frac{1}{3}$.

3. Given $\sqrt{x^2-1}+6=\frac{16}{\sqrt{x^2-1}}$ to find the value of x.

4. Knowing that y varies as x and that when $x=1$, $y=a$, to express the relation between y and x by an equation.

5. Find the value of the repeating decimal 0.23232——

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6. How many different quantities of anything ponderable can be weighed with n different weights?

7. How many changes can be rung with 3 bells out of 6; and how many with the whole peal?

ALGEBRA.

SEPTEMBER, 1886.

[NOTE.—State at the head of your paper what text-book you have studied on the subject and to what extent.]

1. Simplify $\dfrac{3}{x+1} - \dfrac{2x-1}{x^2+\frac{x}{2}+\frac{1}{2}}$.

2. Given $\dfrac{8}{\sqrt{x-3}} - \dfrac{3}{\sqrt{y+3}} = 1$ and $\dfrac{4}{\sqrt{x-3}} + \dfrac{9}{\sqrt{y+3}} = 4$ to find x and y.

3. Prove that if $\dfrac{a_1}{b_1} = \dfrac{a_2}{b_2} = \dfrac{a_3}{b_3} =$ (say) r, then $\dfrac{a_1+a_2+a_3}{b_1+b_2+b_3} = r$; also that $\sqrt{\dfrac{a_1^2+a_2^2+a_3^2}{b_1^2+b_2^2+b_3^2}} = r$.

4. Given $x^2+5=8x+2\sqrt{x^2-8x+40}$, to find the value of x.

5. Find the factors of $x^2 - \dfrac{5}{6}x - 1$.

6. Given $x^2+xy=15$ and $xy-y^2=2$, to find x and y.

7. Simplify (*a*) $\dfrac{\sqrt{a^2+b^2}}{a^2+b^2}$; (*b*) $\sqrt{20}+\sqrt{45}-\sqrt{\dfrac{4}{5}}$; (*c*) $\dfrac{4\sqrt{6}}{3\sqrt{2}}$; (*d*) $(a^{\frac{1}{2}}-2a^{\frac{1}{4}}b^{\frac{1}{4}}+b^{\frac{1}{2}})^{\frac{1}{2}}$; and compare the magnitudes of $8\sqrt{8}$ and $6\sqrt{7}$, and of $\sqrt{2}$ and $\sqrt[3]{3}$ without actually extracting the roots.

8. Deduce formulas for the amount of P dollars for n years, and for the present value of P dollars due n years hence, subject to compound interest, and the interest of one dollar per annum being i. How may both formulas be combined in one?

9. Develop $\dfrac{3+2x}{5+7x}$ into a series of ascending powers of x.

10. Indicate the solution of $10^x=99$.

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TRIGONOMETRY.

JUNE, 1886.

[NOTE.—State at the head of your paper what text-book you have studied on the subject and to what extent.]

1. Explain the rule of signs for angles. Is there any limit to the value of an angle as considered in trigonometry? Express an angle of $\frac{2}{3}$ (of a radian) in degrees. When we speak of an angle $n\pi$ (n being any number) what is understood to be the unit of measure?

2. Explain how the sine and the tangent of an angle vary as the angle varies from 0 to 2π.

3. Prove the following formulæ: $\sin(-\alpha) = -\sin\alpha$; $\cos(-\alpha) = \cos\alpha$; $\tan(-\alpha) = -\tan\alpha$; $\tan\left(\frac{\pi}{2}+\alpha\right) = -\tan\left(\frac{\pi}{2}-\alpha\right)$.

4. Express $\sin\alpha$ and $\cos\alpha$ in terms of $\tan\alpha$; also, $\tan\alpha$ in terms of $\sin\alpha$ and $\cos\alpha$ respectively.

5. Given $\sin(\varphi+\alpha) = \cos(\varphi-\alpha)$ to find φ.

6. Find, with the help of the tables, all the angles between 0° and 360° whose cosine $= \sqrt{0.27}$.

7. In the triangle ABC, given A=43° 27′.3, B=46° 32′.7, AC=4056.5, to find the remaining parts.

TRIGONOMETRY.

SEPTEMBER, 1886.

[NOTE.—State at the head of your paper what text-book you have studied on the subject and to what extent.]

1. (*a*) Find by means of the Tables the cosine and tangent of 317°.3. (*b*) Determine all the angles between 0 and 4π whose cosine is $\frac{1}{2}$; also those whose cosine is $-\frac{1}{2}$.

2. Given $\sin\alpha = a$ to express $\cos\alpha$, $\tan\alpha$, $\cot\alpha$, $\sec\alpha$ in terms of a.

3. Deduce the formula $\sin x + \sin y = 2\sin\frac{1}{2}(x+y)\cos\frac{1}{2}(x-y$ and derive from it $\sin x - \sin y = 2\cos\frac{1}{2}(x+y)\sin\frac{1}{2}(x-y)$.

4. Given the sum of two angles and the ratio of their sines to explain a method for determining the angles.

5. Find an expression for the cosine of an angle of a triangle in terms of the sides of the triangle.

6. Solve the triangle ABC, having given AB=53.94, BC=156.5, B=15° 13′.2.

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ENGLISH GR

JUNE, 1

[State what text-book yo

I. What is the regular terminati
What classes of nouns form their plu

II. Inflect the present and imperfe

III. State the distinction existing
and the new or weak conjugation
illustrative examples of each.

IV. Parse the following sentence:
The objections that were made t
seem to him serious.

CAESAR

JULY 1, 1

I. *Translate as literally as possible:*

1. Ex eo oppido pons ad Helvetios
vel persuasuros, quod nondum bono
viderentur, existimabant; vel *vi* coa
ire paterentur. Omnibus rebus ad p
dicunt, quā die ad ripam Rhodăni on

2. Itaque paulisper apud oppidun
depopulati, omnibus vicis aedificiisqu
sis, ad castra Caesăris omnibus *copii*
passuum minus duobus castra posu
atque ignibus significabatur, ampliu
latitudinem patebant.

3. *Huic* magnis premiis pollicitat
hostes transeat, et, quid fieri velit, e
ad eos venit, timorem Romanōrum p
Caesar a Venĕtis prematur, *docet*, ne
nocte Sabīnus clam ex castris e
auxilii ferendi causā proficiscatu
Cujus loci haec erat natura,
continebatur, uti ex locis supe
t. Hunc ad *egrediendum* neqı
s, dum reliquae naves eo conv
ris exspectavit.
Ab iis cognoscit non longe ex e

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abesse silvis paludibusque *munitum*, quo satis magnus hominum pecorisque numerus convenerit. Oppidum autem Brittani vocant, quum silvas impeditas vallo atque fossâ *munierunt*, quo incursionis hostium vitandae causâ convenire *consuerunt*.

6. Proeliis vero compluribus *factis* secundis atque omni nobilitate Aeduōrum interfectā, tantum potentiā antecesserant, ut magnam partem clientium ab Aeduis ad se transducerent obsidesque ab iis principum filios acciperent, et publice jurare *cogerent* nihil se contra Sequănos consilii *inituros;* et partem finitimi agri per vim occupatam *possiderent*, Galliaeque totius principatum obtinerent.

II. *Grammatical questions, supplementary to the paper on Latin Grammar:*

1. State the construction of all italicized words in passages 1, 2, and 3.

2. Give the principal parts of all italicized words in passages 4, 5, and 6.

3. Quote from the text an example of indirect statement and rewrite it so as to make it direct.

LATIN. (EXERCISES AND GRAMMAR.)

JULY 1, 1886.

I. *Translate into Latin:*

1. The Trevĭri prepare[1] to attack[2] Labienus.

2. The Treviri have attacked Labienus.

3. The Treviri will attack Labienus.

4. The Treviri have collected[3] great[4] forces.[5]

5. Great forces have been collected by the Treviri.

6. The Treviri, having collected great forces (*abl. abs.*) were preparing to attack Labienus.

7. One[6] legion[7] had wintered[8] in the territory[9] of the Treviri.

8. While[10] these things are being done[11] by Caesar, the Treviri, having collected great forces, prepare to attack Labienus together-with[12] (the) one legion, which had wintered in their territory.

9. It is said (that) the Treviri are preparing to attack Labienus.

10. (*Rewrite sentence* 9 *in such a way as to employ direct statement.*)

[1] parāre. [2] adorīri. [3] cogĕre. [4] magnus. [5] copiae (*pl.*). [6] unus. [7] legio (*fem.*). [8] hiemāre. [9] fines (*pl.*). [10] dum. [11] gerĕre. [12] cum. [13] dicĕre.

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II. *Latin Grammar:*

1. Decline *pons, consul, oppidum, vis.*
2. Decline *idem, solus, difficilior.*
3. Compare *bonus, pulcher, malus, proximus, supremus.*
4. Give the synopsis in the active voice of *persuadēre* (*persuāsi, persuāsum*) and in the passive voice of *dicĕre* (*dixi, dictum*).
5. Enumerate all the uses you know of the Genitive case.

CAESAR.

SEPTEMBER 21, 1886.

I. *Translate as literally as possible:*

1. Caesar, quod memoriā tenebat Lucium Cassium consulem occisum, exercitumque ejus ab Helvetiis pulsum et sub jugum missum, *concedendum* non putabat; neque *homines* inimico *animo*, datā facultate per provinciam *itineris* faciendi, temperaturos ab injuriā et maleficio estimabat.

2. Ubi circumjectā multitudine hominum totis moenibus undique in murum lapide *jaci* coepti sunt murusque *defensoribus* nudatus est, testudine factā, *portas* succedunt murumque subruunt. Quod tum facile fiebat. Nam quum tanta multitudo lapides ac tela *conjicerent*, in muro consistendi postestas erat *nulli*.

3. His rebus *adducti* non *prius* Viridovīcem reliquosque duces ex consilio dimittunt, quam ab his sit concessum, arma uti capiant et ad castra contendant. Quā *re* concessā laeti, ut exploratā victoriā, sarmentis virgultisque collectis, *quibus* fossas Romanōrum compleant, ad castra pergunt.

4. Erat ob has causas summa difficultas, quod naves propter magnitudinem, nisi in alto, *constitui* non poterant; militibus autem, ignotis locis, *impeditis* manibus, magno et gravi armorum onere *oppressis*, simul et de navibus *desiliendum* et in fluctibus consistendum et cum hostibus erat pugnandum.

5. Eo proficiscitur cum legionibus; locum *reperit* egregie naturā atque opere munitum; tamen hunc duabus ex partibus oppugnare *contendit*. Hostes paulisper morati militum nostrorum impetum non tulerunt seseque aliā ex parte oppidi *ejecerunt*. Magnus ibi numerus pecoris *repertus*, multique in fugā sunt *comprehensi* atque interfecti.

6. Adventu Caesăris factā commutatione rerum, obsidibus Aeduis *redditis*, veteribus clientelis *restitutis*, novis per Caesărem

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comparatis, quod hi, qui se ad eorum amicitiam aggregaverant, meliore conditione atque aequiore imperio se uti *videbant*, reliquis rebus eorum gratiā dignitateque amplificatā, Sequăni principatum *dimiserant*.

II. *Grammatical questions, supplementary to the paper on Latin Grammar:*

1. State the construction of all italicized words in passages 1, 2, and 3.

2. Give the principal parts of all italicized words in passages 4, 5, and 6.

3. Quote from the text an example of indirect statement and rewrite it so as to make it direct.

LATIN. (EXERCISES AND GRAMMAR.)

SEPTEMBER 21, 1886.

I. *Translate into Latin:*

1. The Romans[1] hold[2] the mountain.[3]

2. The mountain will be held by the Romans.

3. Caesar learns[4] through[5] scouts[6] (that) his (men) are holding the mountain.

4. Caesar learned through scouts (that) the mountain was held by his (men).

5. The Helvetians moved[7] (their) camp.[8]

6. Caesar learns through scouts (that) the Helvetians have moved their camp.

7. The Helvetians will move their camp.

8. Caesar learns through scouts (that) the Helvetians will move their camp.

9. (*Rewrite sentence* 4, *and substitute direct for indirect statement.*)

10. (*Rewrite sentence* 3, *and substitute direct for indirect statement.*)

[1] Romanus. [2] tenēre. [3] mons. [4] cognoscĕre. [5] per. [6] explorator. [7] movēre. [8] castra.

II. *Latin Grammar:*

1. Decline *animal*, *caro*, *equitatus*, *parvus*, *tristis*.

2. Decline *ipse*, *is*, *qualis*.

3. Compare *carus*, *dives*, *primus*, *inferior*, *graviter*, *tuto*.

4. Write the synopsis of the active voice of *facio*, and of the passive of *audio*.

5. State and exemplify the uses of the Accusative case.

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HISTORY OF THE UN

JULY, 18

1. Give the English discoveries i
prior to 1600.
2. Give an account of Bacon's Re
3. Describe the English attacks
French and Indian War.
4. What was Dorr's Rebellion.
5. Give an account of the Wilmot
6. Relate the circumstances lead
President Johnson, and state its resu

N. B.—The dates are to be give

HISTORY OF THE U

SEPTEMBER,

1. Give an account of Raleigh's c
2. Relate the principal events in t
3. What treaty ended the Frenc
were its terms?
4. Describe the attempt at nulli
lina under Jackson's administration.
5. Give the dates of the principal
6. State the causes and results of

N. B.—The dates are to be give

GEOGRAP

JULY, 18

1. Bound the State of Tennessee,
ions of two cities in it.
2. Where does the Ohio River r
course; where does it empty; h
ean; what States does it touch; n
3. What waters lie around the isl
untries are on this island? Giv
ree cities on it.

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4. Where are the following cities: Atlanta, Toronto, Bremen, Singapore, Pittsburg, Naples?

5. What countries of Europe touch the Mediterranean Sea and its branches, beginning west and traveling towards the east?

6. Describe the position of the Isthmus of Panama; what lands does it connect; what waters does it separate; to what country does it belong politically?

7. How many (English) miles wide is the North Temperate Zone?

GEOGRAPHY.

SEPTEMBER, 1886.

1. Bound the State of Florida, and give the names and situations of two cities in it.

2. Where does the Colorado River rise; describe its course; where does it empty; what States and Territories does it teach?

4. Bound Prussia; give the names and course of two rivers in it; also the names and positions of two of its cities.

4. Where are the following cities: Wilmington, Denver, Munich, Manilla, Calcutta, Quebec?

5. What countries touch the Black Sea?

6. Where is British India? What other name or names has it? Name two rivers and two cities in it.

7. How many English miles is it from the Tropic of Cancer to the Arctic Circle?

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The Annual Report will be sent regularly to all graduates who may express the desire to receive it, and who furnish their addresses for the purpose. It is desirable that any change of address should be communicated by the first of January of each year.

For Circulars and other information, address

PROFESSOR G. J. BRUSH,

NEW HAVEN, CONN.

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TWENTY-SECOND REPORT

OF THE

SHEFFIELD SCIENTIFIC SCHOOL

OF

YALE UNIVERSITY,

1887-9.

PRINTED BY ORDER OF THE GENERAL ASSEMBLY.

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TUTTLE, MOREHOUSE & TAYLOR, PRINTERS:
1889.

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STATE BOARI

CONSTITUTING, WITH THE SECRETAI
APPOINTMENT (

Gc

His Excellency PHINEA

Lieutens

His Honor JAMES

State

Hon. EPHRAIM
Hon. JAMES GA
Hon. JOSEPH H

Secretary of Stat

CHARL

Secretary and Ti

GEORG

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REPORT

OF THE

STATE BOARD OF VISITORS.

To the General Assembly of the State of Connecticut:

The State Board of Visitors herewith transmit to your honorable body the Biennial Statement of the Governing Board of the Sheffield Scientific School.

We have performed the duties of our office and respectfully report that we have found the School, in its various departments, in a prosperous and highly satisfactory condition.

We commend to your careful perusal the entire statement of the Governing Board, and we express the hope that in some way additional means may be provided for the extension of the excellent work which this School is doing for our State.

PHINEAS C. LOUNSBURY,
Chairman.

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BIENNIAL STATEMENT

OF THE

GOVERNING BOARD.

Two years ago the twentieth Annual Report of the Board of Visitors of the Sheffield Scientific School was made to the Legislature of Connecticut. When in the autumn of 1887 the State Board met to make their annual inspection, a question of construction of the law at once presented itself for their consideration. Should the report to the Legislature be hereafter an annual or a biennial one? On this point there were apparently conflicting statements in the public acts passed at the session of 1887. The tenth section of the fifth chapter provides that all reports now required to be made annually to the General Assembly should hereafter be made to the Governor at the same period of the year as now required to be made to the General Assembly. On the other hand, the twenty-ninth section of the same chapter provides that the report of the Board of Visitors of the Sheffield Scientific School should be made at each regular session of the General Assembly.

The matter was submitted by the Governor to counsel, and under legal advice no report was published during the year 1887 by the State Board of Visitors. The Governing Board of the School, however, published on their own responsibility a statement of the condition of the institution during the year, but this was necessarily not included among the State documents. The present report covers therefore the period of two years.

The Condition of the School.

During the two years just past the condition of the School has been the most prosperous of any known in its history as regards the number of its students. In the year 1887 the whole number in attendance rose to 292, which was nearly fifty more than had

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ever been at any one time connect
number was surpassed in the fo!l
by the list of students containe
reaches 305. In both years it wa
the greatest increase was shown.
numbered 106; that which entere
120. As usual, Connecticut is the
sented, but students are enrolled fr
country, as will be seen by the l
will be given later.

Necessity of Increa

This large and increasing acces
all parts of the United States, is
success with which the School ha
mand for higher scientific and te
are disadvantages as well as adva
crease of numbers. The pressure
the institution for furnishing inst
heavier. There is urgent need fo
recitation and lecture rooms; and t
which is almost entirely spent in p
unable to provide.

Especially is there need of a ne
providing fuller instruction in mech
technics. For the latter there is fr
be a constantly growing demand;
and friends of this institution will
other scientific institutions of this
this want. The demand for it is
speedily supplied.

Growth of the Depar

The continued growth of the
dered still further room necessary
increasing number of students wh
During the summer of 1888 theref
Hall, which had previously been
room and partly as a private labor
use of the analytical laboratory.

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the dark apparatus room were removed and the enlarged room was fitted up with all of the necessary appliances for chemical study. By this arrangement accommodations for ten additional students in the laboratory of analytical chemistry were secured. At the same time the laboratory in the East wing of Sheffield Hall was fitted up and adapted as a laboratory for the study of organic chemistry. Instruction in this will be given by Mr. W. J. Comstock of the class of 1879, who has spent several years in Germany in the study of this particular branch. These changes already made and one or two others in contemplation will result in practically turning over the whole of Sheffield Hall to the department of Chemistry, and it is evident that this entire building will soon be insufficient to furnish adequate accommodations for those wishing to pursue this particular study.

The National Land-Grant of 1862.

In the last report to the General Assembly, the Governing Board took occasion to reply to the various charges that had been brought against the institution in connection with the national land-grant of the year 1862. They had not then, as they have not now, the slightest objection to the fullest investigation of everything which has been done or has been sought to be done by them in the management and disposal of the funds which have been paid over to them in consequence of the contract made by the trustees of Yale University with the State of Connecticut. The agitation of this subject led to the introduction of a joint resolution directing inquiry as to the expenditure of the income of the Agricultural College Fund. This appeared in the following form:

Resolved by this Assembly:

First, That the Joint Standing Committee on the Judiciary is hereby instructed to examine the legislation, by virtue of which the income of the Agricultural College fund (so-called) is paid to the corporation of Yale College and to report whether or no the said legislation and action had by virtue thereof, binds the State of Connecticut in honor to continue the existing arrangement for the disposition of the income of the aforesaid fund.

Second, Should the conclusion be reached that the State is at liberty to make other disposition of the income of said fund than is now made, the Committee on Agriculture is hereby directed to

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inquire whether the said income as now expended realizes the objects for which it was appropriated by the Congress of the United States; and if not, what further legislation is needed to fully and fairly carry out the intent of said act of appropriation; and to report by bill or otherwise.

This resolution passed the House on the 28th of January, 1887, and passed the Senate on the 8th of the following February. The Judiciary Committee, to whom the matter was referred, gave on the 10th of March a hearing to all those interested in the matters mentioned in the joint resolution. As a result of their examination of the questions which had been raised they introduced the following joint resolution, which was approved by the General Assembly on the 25th of April, 1887:

Resolved by the Assembly: That the act entitled An Act appropriating scrip for public lands, granted to the state under the act of Congress approved July second, 1862 (chapter eleven of the public acts of 1863), and the agreement of the President and Fellows of Yale College executed in accordance with the provisions of said act, together constitute a binding contract inviolably securing to said corporation the income of the land provided for in said act, so long as said corporation shall continue on its part to comply with the terms and conditions of said contract.

Agricultural Experiment Station.

The Congress of the United States passed an act in 1887 appropriating the sum of $15,000 to each of the States and Territories for the support of Agricultural Experiment Stations. This bill, which is popularly known as the Hatch bill, appropriates this money primarily to the colleges established under the national land grant of 1862, but allowed it to be given to experiment stations which are separated from such colleges. As the Connecticut Experiment Station was already in successful operation, and was itself largely an outgrowth of the Scientific School, the Governing Board were glad to waive in its favor any claim they may have had to share in the benefits of this appropriation. A notification to this effect was at once communicated by the director of the School to the director of the Experiment Station, as soon as the inquiry was made of the Governing Board as to any desire on its part to establish an Agricultural Experiment Station under the provisions of this act.

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Changes in the Corps of Instructors.

In June, 1887, Oscar D. Allen, Professor of Analytical Chemistry and Metallurgy, who had been for some time partially disabled from performing his duties, felt it impossible with due regard to his health to continue to give instruction in his department, and handed in his resignation to the Corporation of the University. Professor Allen has been at the head of his department since 1871, and under him it has kept up the high reputation it has enjoyed from the beginning.

At the meeting of the Corporation, in May, 1888, Mr. Horace L. Wells was elected assistant professor of Analytical Chemistry. Mr. Wells was a graduate of the School in the class of 1877. He continued to be a member for the year following, pursuing in it a course of study in Chemistry. For the next two years he was an assistant to the Connecticut Agricultural Experiment Station, and in 1880 accepted the position of chemist at the Colorado Coal and Iron Company, and was stationed at Pueblo, Colorado. There he remained until 1884, when he accepted the position of instructor in Analytical Chemistry in the Sheffield Scientific School. He has been for the last four years practically at the head of this department, the illness of Professor Allen rendering it impossible for him most of the time to discharge his duties.

At this same meeting of the Corporation Mr. Samuel L. Penfield was elected assistant professor of Mineralogy. He was also graduated in 1877, and most of the time since his graduation he has been connected with the institution as an instructor in the department of Mineralogy. Nearly two years, however, have been spent by him in Germany in pursuing further his studies. The Governing Board feel that these additions have added greatly to the efficiency of its teaching force.

States Represented in the School.

The following tables show the States and Countries from which come the students whose names appear on the catalogue during the two years past, and the proportion of numbers that belong to each. The first table gives the numbers for the academic year 1887–8.

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	Graduates.	Seniors.	Juniors.	Freshmen.	Special.	Total.
1. California	--	2	5	1	--	8
2. Colorado	--	3	--	--	--	3
3. Connecticut	8	31	28	41	1	109
4. Dakota	--	1	--	--	--	1
5. Delaware	--	--	--	1	--	1
6. District of Columbia	--	--	--	1	1	2
7. Illinois	--	8	5	16	--	29
8. Indiana	--	--	1	--	--	1
9. Kentucky	--	--	2	2	--	4
10. Louisiana	--	1	1	--	--	2
11. Maine	1	1	2	--	--	4
12. Massachusetts	--	1	2	--	--	3
13. Michigan	--	--	--	1	--	1
14. Minnesota	--	--	1	2	--	3
15. Missouri	2	--	1	3	--	6
16. Nebraska	--	1	--	--	--	1
17. New Hampshire	1	--	1	1	--	3
18. New Jersey	--	--	3	1	--	4
19. New York	5	14	16	20	1	56
20. Ohio	2	3	7	8	1	21
21. Pennsylvania	1	3	6	5	1	16
22. Rhode Island	--	3	--	3	--	6
23. West Virginia	--	--	1	--	--	1
24. Canada	--	--	--	1	--	1
25. England	--					
26. Japan	--					
27. Sandwich Islands	--					
28. Turkey in Asia	--					
Total	20					

The following is the table for t

	Graduates.
alifornia	--
olorado	1
onnecticut	8
elaware	--
istrict of Columbia	--
linois	1
ıdiana	--
ansas	--
entucky	--
ouisiana	1
laine	2
aryland	1
assachusetts	--
lichigan	--

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	Graduates.	Seniors.	Juniors.	Freshmen.	Special.	Total.
15. Minnesota	--	--	1	2	--	3
16. Missouri	--	1	2	1	--	4
17. Nebraska	--	--	--	4	--	4
18. New Hampshire	1	--	--	--	--	1
19. New Jersey	2	3	1	1	--	7
20. New York	5	13	14	28	1	61
21. Ohio	--	6	7	7	--	20
22. Pennsylvania	2	5	4	5	1	17
23. Rhode Island	--	--	3	2	--	5
24. Tennessee	--	--	--	1	--	1
25. West Virginia	--	1	--	--	--	1
26. Wisconsin	--	--	--	2	--	2
27. Canada	--	--	1	--	--	1
28. England	--	--	--	--	1	1
29. Japan	--	--	--	2	--	2
30. Sandwich Islands	1	1	--	--	--	2
31. Turkey in Asia	--	1	--	--	--	1
Total	24	73	80	120	7	305

Gifts.

The following gifts to the department of Mechanical Engineering are here gratefully acknowledged.

From Mr. George Westinghouse, Jr., a very valuable gift consisting of all the parts of a Westinghouse Automatic Air Brake, including Air Pump and Reservoirs, and constituting a complete working apparatus. This is accompanied by a separate set of valves, cut open so as to show the interior and illustrate their operation.

From Mr. John Caldwell, Secretary of the Fuel, Gas and Electric Engineering Company, Pittsburgh, Pa., a Westinghouse Gas Pressure Regulator, made in section so as to show its construction and working.

From Messrs. Remington and Hawthorn, Providence, R. I., a portfolio of about 50 Blue Prints of working drawings of the details, complete, of a large Corliss Steam engine, designed and erected by them.

Additions to the Zoölogical Collections.

A. E. Verrill, Curator; K. J. Bush and C. E. Bush, Assistants.

The following additions to the collections have been received since the last report.

A. H. Verrill. Herring gull, New Haven; Burgomaster gull, Lake George; pintail, gadwall, and Shoveller ducks, Iowa,

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(mounted); annelids (*Cistenides Gouldii*), found at Savin Rock, Conn., in February; rare bat (*Vespertilio vagus*), New Haven; opossum from Derby, Conn.; porcupine from New Hampshire; water snake from New Haven; peregrine falcon, Monomoy Island, Mass.; magpie, Dakota, and various other birds (mounted).

G. E. Verrill, S. S. S. '85. Painted longspurs, from Kansas; murre, auk, parasitic jager, harlequin duck, sooty shearwater, eider, widgeon, hooded merganser, and other American birds (mounted); Caracarra eagle; red shouldered hawk, and little blue heron, from Florida.

Capt. Chas. Hervey Townshend. A fine specimen of red sponge (*Microciona prolifera*); large horse-shoe crab, alive, in the act of changing its shell; young oysters, alive, from New Haven.

Ernest F. Coe. Bonaparte's gull (*Larus Philadelphia*) and a red-shouldered hawk (*Buteo lineatus*), mounted; skeleton of red-tailed hawk, from New Haven. Purchased.

Miss Kate Foote. Shells and one starfish (*Asterias sp.*) from Alaska.

Dr. J. W. Barker, Woodbridge, Conn. A young deer brought from St. Croix, W. I., in 1884, by Capt. Noys Perkins. Purchased.

H. E. Fitz, New York. A specimen of round clam (*Venus mercenaria*) showing its growth during several years.

Prof. Daniel C. Eaton. A large number of spring-tails (*Podura*) found on the snow in January.

Joseph Wilcox, Philadelphia, Pa. Fossil shell from Florida. In exchange.

Henry Hotchkiss Townshend. A large specimen of crab (*Cancer pagurus*), said to be from Norway; purchased in the Liverpool market.

Prof. Archibald Liversidge. A number of specimens of brachiopods (*Waldheimia flavescens*), from Sidney, Australia.

O. A. Rose. A living specimen of tarantula taken among bananas from Aspinwall.

Ensign W. L. Howard, U. S. Navy. A leech (*Clepsine elegans*) from Alaska.

A. G. Remington. A large moth (*Telea polyphemus*).

H. N. Hall. Young patridges from North Haven, Conn.

Rev. Lewis Grout, Yale '42. Land shells from South Africa.

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Horace Bowman. Oyster shell with curious excrescence; hammer-headed shark, New Haven.

Mr. Fred. Dorman. Sparrow hawk, Hamden, Conn.

Prof. W. D. Whitney. Basketworms, alive, from Middletown, N. J.

W. H. Gardner. Double crested cormorant and red-necked loon (mounted), from Branford, Conn. Purchased.

Prof. A. E. Verrill. Rare sea birds, Cory's shearwater (*Puffinus borealis*), skua gull (*Megalestris skua*), and parasitic jager (*Stercorarius parasiticus*), Wood's Holl, Mass. (mounted); a very rare jelly fish (*Nectopilema Verrilli*), taken at Thimble Islands, Conn., October, 1888.

John Lounsbury. Hen hawk from Oxford, Conn.

John P. Terry. Solpuga, alive, from El Paso, Texas.

Dr. Fred. Sumner Smith, Yale, '79. Lizard from Bermuda; moth from West Hartford, Conn.

Prof. J. D. Dana. Fossil corals from Oahu; several books for the Zoölogical Library; twigs bored by the oak pruner, from Long Island.

Prof. H. A. Newton. Moonfish from Fortress Monroe, Va.

Stacy H. Ward. Eleven species of birds' eggs and seven nests.

Richard Westbrook. Blood worms from the heart of a Japanese dog.

Prof. O. C. Marsh. Marine shells and several specimens of *Hyalonema* from Japan.

Dr. G. Baur. Leech found alive on soft-shell turtle from Ohio.

Geological Department of Peabody Museum. Soft-shell turtles (*Trionyx*).

Mrs. Wilder Smith. Pine wood showing borings and tubes of shipworm (*Teredo navalis*) from South Lyme, Conn.

Capt. C. W. Hulse, "Steamer Enterprise." Tilefish from off New Haven Light; series of starfishes (*Asterias Forbesii*), showing abnormal developments and variable number of arms, Long Island Sound.

A. G. Dana, Yale '83. "Fisher's Conchyliologie" to Zoölogical Library.

Miss Edith J. Blakeslee. Nest of humming-bird from Plantsville, Conn.

Prof. A. S. Packard. Cast of fossil crustacean (*Adelocaris Peruvianus*) taken from the type specimen.

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A. Hermann. Two otters, one adult from Cheshire, Conn., and one young from Lake Saltonstall, East Haven, Conn. Purchased.

Unknown donor, through Mr. H. T. Woodman. A very large specimen of giant clam (*Tridacna gigas*) from the Indian Ocean.

J. B. Hatcher, S. S. S. '84. Skin of prong-horned antelope from Wyoming; two skins of big-horned sheep from Montana; lignite bored by teredo (?), from the Tertiary clays of Virginia.

Public Lectures.

During the past two years the annual course of lectures to mechanics and others has been given in the lecture room in North Sheffield Hall. The names of the lecturers and the subjects of the lectures were as follows:

Twenty-First Annual Course, 1887.

I. Tuesday, Feb. 22.—Earthquakes. Prof. Brewer.
II. Friday, " 25.—Science and the Spiritual. Prof. DuBois.
III. Tuesday, Mar. 1.—The Cañon of the Colorado. Mr. William Harper.
IV. Friday, " 4.—State Railroad Ownership. Prof. Hadley.
V. Tuesday, " 8.—Recent Additions to the Nebular Hypothesis. Prof. Hastings.
VI. Friday, " 11.—Butter. Dr. E. H. Jenkins.
VII. Tuesday, " 15.—The Dinocerata, Extinct Gigantic Animals. Mr. E. H. Barbour.
VIII. Friday, " 18.—Sea Coast Defense. Major W. R. King, U. S. Engineers.
IX. Tuesday, " 22.—Handicraft. Prof. Weir.
X. Friday, " 25.—The German Military Organization. Mr. E. V. Raynolds.
XI. Tuesday, " 29.—Life in Modern Greece. Prof. Seymour.
XII. Friday, April 1.—Some Remarkable Habits of the Lower Animals. Prof. Verrill.

Twenty-Second Annual Course, 1888.

I. Tuesday, Feb. 14.—Science and Miracle. Prof. DuBois.
II. Friday, " 17.—The American Isthmus. Prof. Brewer.
III. Tuesday, " 21.—South Eastern Alaska. Mr. L. V. Pirsson.
IV. Friday, " 24.—Mosses. Prof. Daniel C. Eaton.
V. Tuesday, " 28.—Charity and Poo
VI. Friday, Mar. 2.—Animal Mechani
VII. Tuesday, " 6.—Egypt.
VIII. Friday, " 9.—My first Winter
IX. Tuesday, " 13.—Railroad Service
X. Friday, " 16.—Athens.
XI. Tuesday, " 20.—The Gypsies.
XII. Friday, " 23.—Electric Second

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Lectures on Military Science.

Courses of lectures on Military Science, by officers of the U. S. Engineering School at Willets Point, were delivered in North Sheffield Hall as part of the instruction in the School during the second term of the years 1887 and 1888. The order and subjects of the lectures are indicated in the following programmes:

Course for 1887.

I. Monday, Feb. 28.—Armies, their Organization, Equipment and Tactics. Lieut. W. L. Sibert, U. S. Engineers.

II. Friday, Mar. 4.—Moving, Supplying and Sheltering Troops. Lieut. H. M. Chittenden, U. S. Engineers.

III. Monday, " 7.—Strategy and Grand Tactics. Lieut. C. E. Gillette, U. S. Engineers.

IV. Friday, " 11.—Light Siege and Sea Coast Artillery. Lieut. Irving Hale, U. S. Engineers.

V. Monday, " 14.—Field and Permanent Fortifications: their Attack and Defense. Capt. J. G. D. Knight, U. S. Engineers.

VI. Friday, " 18.—Sea Coast Defenses, Vessels which Attack them, and Torpedo Systems. Major W. R. King, U. S. Engineers.

Course for 1888.

I. Monday, Feb. 27.—Armies, their Organization, Equipment and Tactics. Lieut. Mason M. Patrick, U. S. Engineers.

II. Friday, Mar. 2.—Moving, Supplying and Sheltering Troops. Capt. Eric Bergland, U. S. Engineers.

III. Monday, " 5.—Strategy and General Tactics. Lieut. Charles S. Riché, U. S. Engineers.

IV. Friday, " 9.—Light, Siege and Sea Coast Artillery. Lieut. Irving Hale, U. S. Engineers.

V. Monday, " 12.—Field and Permanent Fortifications: their Attack and Defense. Lieut. Joseph E. Kuhn, U. S. Engineers.

VI. Friday, " 16.—Sea Coast Defenses, Vessels which Attack them, and Torpedo Systems. Major W. R. King, U. S. Engineers.

Anniversaries.

In the following schedules are given the names of the candidates for degrees in the years 1887 and 1888. The subjects of the graduation theses are also published. The names in the first lists of the Bachelors of Philosophy in each year are of those who stood highest in their respective courses. Those marked with an asterisk read theses in the evening.

The exercises of the Graduating Class of 1887 were held in North Sheffield Hall on the evening of Tuesday, June 28. The names of the candidates are here given, as well as the list of prizes announced at that Anniversary.

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Mechanical Engineers (3).

Duane Judson Kelsey, Ph.B., *Killingworth*. On the Theory of the Centrifugal Pump, and a Design for a Pumping Plant.

Sidney Armour Reeve, Ph.B., *Dayton, O.* Design and Computations for a Compound Marine Engine.

Curtiss Chauncey Turner, Ph.B., *Omaha, Neb.* Review of the Work on a Section of the New Croton Aqueduct, and the Machinery used in its Construction.

Bachelors of Philosophy (59).

* Robert Clayton Auger (Mechanical Engineering), *West Haven*. On the Westinghouse Air Brake.

Herbert Spencer Bullard (Mechanical Engineering), *Hartford*. On Centrifugal Pumps.

Richard Augustus Chapman (Mechanical Engineering), *Rye, N. Y.* On Safety Valves.

* Robert Fisher Gibson (Mechanical Engineering), *York, Pa.* On Centrifugal Extractors.

Wilfred Elizur Griggs (Mechanical Engineering), *Waterbury*. On the Principles of Ventilation and an Example of their Practical Application.

* Edgar Burton Harger (Civil Engineering), *Oxford*. On Compressed Air and its Applications.

Joseph Cooke Jackson, Jr. (Select), *New York City*. On the Adoption of the Postal Savings Bank System in the United States.

Lawrence Bates Jencks (Mechanical Engineering), *Stamford*. On Water Pressure Engines.

* Leonard Abbott Jenkins (Agriculture), *Dresden, Saxony*. On Irrigation.

* Charles Sherman Jewett (Biology), *Buffalo, N. Y.* On the Nature of the Liver Sugar.

Edward Linsley Maltby (Mechanical Engineering), *Northford*. On the Worthington Compound Pumping Engine with High Duty Attachment.

* Oscar Harmon Short (Select), *New York City*. On Hexameter Verse in English.

Frink Mansfield Smith (Civil Engineering), *East Haven*. On Weights and Economic Proportions of Iron Railway Bridges.

* Edwin Starr Sperry (Chemistry), *Ansonia*. On the Gooch Method for the Determination of Boracic Acid, and its Application to the Analysis of Howlite.

Merton Pierpoint Stevens (Mechanical Engineering), *New Haven*. On the Manufacture of Shot Cartridge Shells.

* Alfred John Wakeman (Chemistry), *Green's Farms*. On the Basic Lead Nitrates.

* Nathaniel P. Washburn (Biology), *Bridgewater, Mass.* On the Influence of Urethan on Metabolism.

Frank Otto Walther (Chemistry), *Brooklyn, N. Y.* On New Nitro Derivatives of Oxanilide.

* Edward Gilbert Williams (Civil Engineering), *Essex*. On Systems of Sewage and Sewage Disposal.

* George Henry Wood (Select), *Dayton, O.* On the Legality of Boycotting.

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HENRY FREDERICK ADAMS (Select), *Westport.* On the Influence of Antipyrine on Metabolism.

ELMER ELLSWORTH BENNETT (Civil Engineering), *Plainfield.* On Hydraulic Foundations.

WILLIAM HENRY COBURN (Civil Engineering), *Indianapolis, Ind.* On Reservoirs.

HARRY FITCH COLEMAN (Civil Engineering), *Logansport, Ind.* On the Disposal of Sewage.

LEWIS ATTERBURY CONNER (Biology), *New Albany, Ind.* On the so-called Casein-Dyspeptone.

DAVID MARK CUMMINGS (Select), *Chicago, Ill.* On Cork.

JULIUS GILBERT DAY (Select), *Seymour.* On India Rubber.

WILLIAM GREENHOW DUANE (Select), *Omaha, Nebr.* On Industrial Arbitration.

EDWARD WARBURTON DURANT, Jr. (Select), *Stillwater, Minn.* On Pine Lumber.

ISADORE DYER, Jr. (Biology), *Galveston, Tex.* On the Germ Theory of Disease.

ARTHUR MANSFIELD EVERIT (Mechanical Engineering), *New Haven.* On the Boston Sewerage System, and the Machinery Involved.

RAYMOND THOMPSON FRENCH (Biology), *Seymour.* On the Influence of Training and Environment on Hereditary Degeneration in Certain Classes of Human Society.

FRANCIS FREDERICK GEORGER (Select), *New York City.* On the Fur-bearing Animals of North America.

CHARLES JOSEPH GOLDMARK (Mechanical Engineering). *New York City.* On Ice Machines.

GEORGE CONRADT HAM (Civil Engineering), *Washington Hollow, N. Y.* On Modern Tunnelling in America.

HARRY LEON HAMLIN (Select), *Chicago, Ill.* On Jeremy Collier and the Comic Dramatists of the Restoration.

HERBERT LEOPOLD HART (Mechanical Engineering), *New York City.* On the Blake Crusher.

JAMES HENRY HAYDEN (Civil Engineering), *New York City.* On the Construction of the South Pass Jetties.

WILLIAM BRISBANE HICKOK (Civil Engineering), *Litchfield.* On the Theory of the Economic Location of Railways.

MARVIN D. HUBBELL (Biology), *New York City.* On Bacteria in their Relation to Sanitary Science and to Medicine.

FREDERICK SHEFFIELD KELLOGG (Select), *Utica, N. Y.* On Timber-trees and Cabinet Woods.

GRAYSON GUTHRIE KNAPP (Chemistry), *Auburn, N. Y.* On Experiments with Zirconia.

HARLEY JAMES MORRISON (Chemistry) *Cincinnati, O.* On Fox and Wanklyn's Method for the Determination of Glycerine.

WILLIAM PARTRIDGE ORDWAY (Chemistry), *Boston, Mass.* On Volhardt's Volumetric Method for the Determination of Manganese.

COMILO ENRIQUE PANI (Civil Engineering), *Aguacalientes, Mexico.* On Lighthouse Construction and Illumination.

EDMUND BISHOP PATTERSON (Chemistry), *Allegheny City, Pa.* On the Determination of Phosphorus in Iron and Steel.

FRANK ADELBERT PAUL (Mechanical Engineering), *New Haven.* On the Different Methods of Ignition in Gas Engines.

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CHARLES EUGENE PHILLIPS (Mechanical Egineering), *Southington.* On Water Meters.

WILLIAM THOMAS RAINEY (Chemistry), *Cleveland, O.* On a Test of Eschka's Method for the Determination of Sulphur in Fluids.

HARRIS SMITH REYNOLDS (Select), *Poughkeepsie, N. Y.* On Milling.

JOHN ROBERT WHEATON SARGENT (Select), *Chicago, Ill.* On the Height of Land.

WILLIAM MARCELIN SCAIFE (Mechanical Engineering), *Allegheny City, Pa.* On the Manufacture of Wrought Iron Pipe.

EDWIN COUPLAND SHAW (Mechanical Engineering), *Buffalo, N. Y.* On Hydraulic Elevators.

EDWARD ARTHUR SMITH (Mechanical Engineering), *Middletown.* On the Pickering Governor.

FRANCIS TIMOTHY SMITH (Civil Engineering), *Simsbury.* On the Location and Setting-out of Railway Curves.

ARTHUR PEALE SUMMERS (Biology), *Colorado Springs, Col.* On the Histology of the Alimentary Canal of the Cat.

FRANK WARREN WENTWORTH (Civil Engineering), *Chicago, Ill.* On the Stability and Construction of Retaining Walls.

CHARLES PERCY WILCOX, B.S. (Chemistry), *Media, Pa.* On New Nitrobrom Derivatives of Oxanilide.

ROBERT MCKNIGHT WOODS (Chemistry), *New Haven.* On the Separation of Iron and Manganese.

PRIZES.

CLASS OF 1887.

For excellence in Civil Engineering, the prize divided between EDGAR BURTON HARGER, Oxford, and EDWARD GILBERT WILLIAMS, Essex, with honorable mention of FRINK MANSFIELD SMITH, East Haven.

For excellence in Dynamic Engineering, the prize awarded to ROBERT FISHER GIBSON, York Pa., with honorable mention of ROBERT CLAYTON AUGUR, West Haven, and EDWARD LINSLEY MALTBY, Northford.

For excellence in German, the prize awarded to EDGAR BURTON HARGER, Oxford.

CLASS OF 1888.

For excellence in the Mathematics of Junior Year, the prize divided between EDWIN HOYT LOCKWOOD, New Canaan, and PERCY FRANKLYN SMITH, New Haven, with honorable mention of MORGAN WALCOTT, New York City.

CLASS OF 1889.

For excellence in all the Studies of Freshman Year, the prize awarded to JOHN AUGUSTUS HARTWELL, Unionville, N. Y.

For excellence in Chemistry, the prize awarded to FREDERICK HOWARD ELLSWORTH, Hartford, with honorable mention of GUSTAVE ERWIN HUTTELMAIER, Knoxville, Tenn., GEORGE ALFRED LUND, West Stratford, and CHARLES EMERSON STONE, Spencer, Mass.

For excellence in Physics, the prize awarded to JOHN AUGUSTUS HARTWELL, Unionville, N. Y., with honorable mention of FREDERICK HOWARD ELLSWORTH, Hartford, LLOYD WIEGAND FISHER, Westtown, N. Y., WILLIAM BREWSTER MORRISON, Willimantic, and WILLIAM BELKNAP NEWBERRY, New Haven.

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For excellence in German, the prize awarded to CHARLES EMERSON STONE, Spencer, Mass.

For excellence in Mechanical Drawing, the prize divided between FREDERICK HOWARD ELLSWORTH, Hartford, LLOYD WIEGAND FISHER, Westtown, N. Y., and GUSTAVE ERWIN HUTTELMAIER, Knoxville, Tenn.

For excellence in Mathematics, the prize divided between GUSTAVE ERWIN HUTTELMAIER, Knoxville, Tenn., and KENYON VICKERS PAINTER, Cleveland, O.

For excellence in English Composition, *1st prizes*, WILLIAM DARROW CARTER, Waterbury, and WILLIAM BELKNAP NEWBERRY, New Haven; *2nd prizes*, MARK SPAULDING BRADLEY, East Jaffrey, N. H., GUSTAVE ERWIN HUTTELMAIER, Knoxville, Tenn., and WILLIAM BREWSTER MORRISON, Willimantic; *3rd prizes*, ARTHUR SANFORD CHENEY, New Haven, LLOYD WIEGAND FISHER, Westtown, N. Y., and GUTHRIE MINOR WILSON, Bardstown, Ky.

The Exercises of the Graduating Class of 1888 were held in North Sheffield Hall in the evening, Tuesday, June 26th. The following is the list of the candidates for degrees, and of the prizes that were announced on that occasion.

MECHANICAL ENGINEER.

CALVERT TOWNLEY, Ph.B., *Cincinnati, O.* On the Alternating Current System of Incandescent Lighting.

BACHELORS OF PHILOSOPHY (77).

JOSEPH ALBRIGHT ARCHBALD (Select), *Scranton, Pa.* On the Anthracite Coal Monopoly in Pennsylvania.

CHARLES BART BERGER (Select), *Denver, Col.* On the Surplus Revenue Deposits in the National Banks.

GEORGE BART BERGER (Civil Engineering), *Denver, Col.* On Tunneling.

*RICHARD SIDNEY CURTISS (Chemistry), *Stratford.* On Investigations on Cinchonidine.

*CARLTON MELVILLE DEWOLF (Select), *New York City.* On the Decay of American Shipping.

FRANK HAROLD FARQUHAR (Select), *York, Pa.* On the Influence of Roman Law on the Law of England.

*FELIX KLEEBERG (Chemistry), *New Haven.* On the Nitro Derivatives of Oxaltoluide.

HOWARD LIVINGSTONE ISBELL (Mechanical Engineering), *Union City.* On the Steam Hammer.

*EDWIN HOYT LOCKWOOD (Mechanical Engineering), *New Canaan.* On a Bessemer Blowing Engine.

JAMES AUGUSTUS NELSON (Civil Engineering), *Bridgeport.* On Topographical Surveying.

CHARLES NORRIS, JR. (Biology), *New York City.* On Casein Peptone.

*ELBERT ELLSWORTH NORTON (Civil Engineering), *New Haven.* On Road Making and Street Paving.

FRANKLIN T. PARLIN (Select), *Casselton, Dak.* On Farming in Dakota.

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*George Brinckerhoff Richards (Select), *New Haven.* On Euphuism.

Edwin Wright Robinson (Civil Engineering), *New Haven.* On the Economic Principles of Railway Location.

*Philemon Tecumseh Sherman, B.A. (Select), *St. Louis, Mo.* On Internal Migration in the United States.

Ernest Ellsworth Smith (Biology), *New Haven.* On Glycogen and Glycogenic Acid.

*Percy Franklyn Smith (Mechanical Engineering), *New Haven.* On the Efficiency of Toothed Gearing.

Frederick William Spanutius (Chemistry), *New Haven.* On the Determination of Fluorine.

*Howard Canning Taylor (Biology), *Green's Farms.* On the Influence of Acetanilide on Metabolism.

*Charles Alling Tuttle (Biology), *New Haven.* On the Caseose Bodies formed in Gastric Digestion.

*Morgan Wolcott (Civil Engineering), *New York City.* On the Manhattan Elevated Railway.

John Childe Anderson (Select), *Sing Sing, N. Y.* On Convict Labor.

William Hill Bean (Mechanical Engineering), *New Haven.* On Spur and Bevel Gear Cutting.

William Tillinghast Bull (Select), *Newport, R. I.* On Disinfection.

William Clarke Catlin (Chemistry), *Providence, R. I.* On the Determination of Zinc as Sulphide.

George Robert Carter (Civil Engineering), *Honolulu, S. I.* On the History and Future of Sugar Manufacture.

William Williams Crehore, B.A. (Civil Engineering), *Cleveland, O.* On the Designing of Railroad Bridges in Ordinary Use.

James Henry Coleman (Civil Engineering), *New York City.* On Keel versus Centreboard.

George David Colton (Mechanical Engineering), *Collinsville.* On Hydraulic Forging.

Charles Edward Curtis (Civil Engineering), *New Haven.* On Railway Grade Crossings.

Jesse Chase Dann (Select), *Buffalo, N. Y.* On the Diminution of American Forests and Timber.

Henry Lewis Davis (Mechanical Engineering), *Wallingford.* On Indicator Diagrams.

George Howard Davison (Agriculture), *New York City.* On Lawns.

William Henry Davol, Jr. (Chemistry), *Brooklyn, N. Y.* On Basic Zinc Sulphates.

Robert Russel Dickey (Select), *Dayton, O.* On Cattle Growing on Western Ranges.

John Eufemio Dockendorff (Biology), *Brooklyn, N. Y.* On the Influence of Paraldehyde on Metabolism.

John Feeter Easterbrook (Mechanical Engineering), *New Haven.* On Saws and Sawing Machinery.

Henry Hays Ellis (Civil Engineering) *Oxford, Me.* On the Effect of Grade and Curvature on Railway Location.

John Ellis Field (Mechanical Engineering), *Denver, Col.* On Ore Crushing.

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RICHARD HUNTINGTON FRANCHOT (Select), *Schenectady, N. Y.* On Petroleum.

DEANE FUNK (Agriculture), *McLean, Ill.* On Aberdeen Angus Cattle.

GEORGE FRANCIS GARNEAU, B.A. (Select), *St. Louis, Mo.* On the Masque in Dramatic Literature.

HENRY KELLOGG GOETCHIUS (Chemistry), *New York City.* On Basic Cupric Sulphates.

JAMES DOUGLAS GOLD (Biology), *West Cornwall.* On Ventilation.

FRANKLIN MOSES GRAY (Select), *Chicago, Ill.* On the Restriction of Foreign Immigration.

HOWARD GREER, JR. (Mechanical Engineering), *Chicago, Ill.* On Iron Rolling.

MATTHEW GRISWOLD, JR. (Mechanical Engineering), *Erie, Pa.* On the Manufacture of "Extra Finished Hollow Ware."

FRED R. HAMLIN (Select), *Chicago Ill.* On the Domestic Slave Trade.

CHARLES MERRITT HEMINGWAY (Biology), *Watertown.* On Water Supply and the Public Health.

HORACE SEDGWICK HART, B.A. (Biology), *New Haven.* On Elastin and the Elastose Bodies.

NOBLE FOSTER HOGGSON (Select), *New Haven.* On the History of the English Race-Horse.

HARRY GARRYBRANT JENNER (Biology), *Dayton, O.* On the Heredity of Pauperism and Crime.

CYRUS FIELD JUDSON (Mechanical Engineering), *New York City.* On the Otto Gas Engine.

GEORGE CONVERSE KIMBALL (Select), *Hartford, Conn.* On the French Spoliation Claims.

EDWARD LAMBERT LEEDS (Mechanical Engineering), *Stamford.* On Transmission Dynamometers.

THOMAS ALBERT LEGLER, JR. (Select), *Dayton, O.* On the History and Interpretation of the Original Copyright Statute.

LOUIS LESASSIER (Civil Engineering), *New Orleans, La.* On the Theory and Practice of Cable Roads.

SAMUEL HARKNESS MCCREA, JR. (Select), *Chicago, Ill.* On the Dressed Beef Cases.

GEORGE GRANT MASON (Civil Engineering), *Milburn, Ill.* On Bridge Disasters, their Cause and Cure.

WILLIAM SMITH MASON (Civil Engineering), *Milburn, Ill.* On Railroad Transportation.

CHARLES GRIFFIN MILLER (Select), *New Rochelle, N. Y.* On Gladstone and Bismarck.

EDWARD STEWARD MOORE (Select), *New London, Conn.* On the Struggle for the Freedom of the Press.

SELDEN YALE OSBORN (Mechanical Engineering), *New Haven.* On the Clause Printing Press.

JOHN ERSKINE PATRICK (Select), *Omaha, Neb.* On Omaha.

FRANCIS COLE PRATT (Mechanical Engineering), *Hartford.* On Machine Guns.

JOHN GOODELL PROUTY (Select), *Spencer, Mass.* On Modern Immigration to the United States.

JOHN ROGERS, JR., B.A. (Biology), *New York City.* On Chondrin and its Primary Decomposition Products.

HENRY CHARLES SCHWAB (Select), *Chicago, Ill.* On some Considerations on the Growth of Large Cities.

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CHARLES KIRTLAND SHELTON (Chemistry), *Bridgeport.* On some Ammonium-Magnesium Double Salts.

SHIUKICHI SHIGEMI (Biology), *Imabari, Japan.* On the Germ Theory of Disease.

RALPH HERBERT SMITH (Select), *Waterbury, Conn.* On the Brass Industry of Waterbury.

CHARLES WEAVER STEWART (Biology), *Newport, R. I.* On the Influence of several Modern Therapeutic Agents on Salivary and Gastric Digestion.

WILLIAM CONQUEST TUCKER (Civil Engineering), *New York City.* On the 147th Street Outlet Sewer of New York City.

RALPH MCINTOSH WILCOX (Civil Engineering), *Portland, Me.* On the New Croton Aqueduct.

FRANK CLARK WOODRUFF (Select), *Orange.* On Agriculture in Connecticut.

GEORGE STANLEY WOODWARD, B.A. (Biology), *Wilkes-Barre, Pa.* The Erythro and Achroodextrin formed in Salivary Digestion.

PRIZES.

CLASS OF 1888.

For excellence in Civil Engineering, the prize awarded to MORGAN WALCOTT, New York City, with honorable mention of JAMES AUGUSTUS NELSON, Bridgeport.

For excellence in Mechanical Engineering, the prize awarded to EDWIN HOYT LOCKWOOD, New Canaan, with honorable mention of HOWARD LIVINGSTONE ISBELL, Union City, and PERCY FRANKLYN SMITH, New Haven.

CLASS OF 1889.

For excellence in the Mathematics of Junior Year, the prize divided between FREDERICK HOWARD ELLSWORTH, Hartford, and WILLIAM BREWSTER MORRISON, Willimantic, with honorable mention of KENYON VICKERS PAINTER, Cleveland, O.

For excellence in German, the prize awarded to CHARLES EMERSON STONE, Spencer, Mass., with honorable mention of BOYNTON WELLS MCFARLAND, New Haven, and WILLIAM BREWSTER MORRISON, Willimantic.

CLASS OF 1890.

For excellence in all the Studies of Freshman Year, the prize awarded to ALEXANDER WILLIAM EVANS, New Haven, with honorable mention of WILLIS JUDSON FENN, Plymouth.

For excellence in Chemistry, the prize awarded to HARVEY MERRILL LAWSON, Union, with honorable mention of ALEXANDER WILLIAM EVANS, New Haven.

For excellence in Physics, the prize divided between JULIAN DUBOIS, Hudson, N. Y., and ALEXANDER WILLIAM EVANS, New Haven, with honorable mention of WILLIS JUDSON FENN, Plymouth, OLIVER SMITH LYFORD, JR., Chicago, Ill., and WALTER DODGE, Stamford.

For excellence in Mathematics, the prize divided between ALEXANDER WILLIAM EVANS, New Haven, and WILLIS JUDSON FENN, Plymouth, with honorable mention of FRANK RUSSELL RICH, New Haven.

For excellence in German, the prize awarded to ALEXANDER WILLIAM EVANS, New Haven.

For excellence in Mechanical Drawing, the prize awarded to WILLIS JUDSON FENN, Plymouth.

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PROGRAMME OF STUDIES

AND

CATALOGUE,

FOR THE COLLEGE YEAR, 1888-89.

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CALENDAR.

1888.		
20 Sept.	Thursday,	First Term begins.
20 Dec.	Thursday,	First Term ends.
1889.	**Winter Vacation of two weeks.**	
8 Jan.	Tuesday,	Second Term begins.
17 April,	Wednesday,	Spring Recess begins.
24 April,	Wednesday,	Spring Recess ends.
24 June,	Monday,	Meeting of Appointing Board.
24 June,	Monday,	Anniversary.
26 June,	Wednesday,	Commencement.
27 June,	Thursday,	Examination for Admission.
28 June,	Friday,	Examination for Admission.
29 June,	Saturday,	Examination for Admission.
	Summer Vacation of twelve weeks.	
17 Sept.	Tuesday,	Examination for Admission.
18 Sept.	Wednesday,	Examination for Admission.
19 Sept.	Thursday,	First Term begins.
19 Dec.	Thursday,	First Term ends.

ABBREVIATIONS.

S. H.,	Sheffield Hall.
N. S. H.,	North Sheffield Hall.
TR.,	Treasury Building.
D.,	Durfee College.
F.,	Farnam College.
E.,	East Divinity Hall.
W.,	West Divinity Hall.
P. M.,	Peabody Museum.
A.,	Absent on leave.

In the buildings belonging to the Sheffield Scientific School, the rooms numbered from 1 to 21 are in Sheffield Hall; from 26 to 58 in North Sheffield Hall.

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President.

REV. TIMOTHY DWIGHT, D.D., LL.D.

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HIS HONOR JAMES L. HOWARD, HARTFORD.
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Treasurer.

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WILBUR F. DAY.

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GOVERNING BOARD,

APPOINTED BY THE CORPORATION OF YALE UNIVERSITY.

President.

REV. TIMOTHY DWIGHT, D.D., LL.D., (7 TR.) 126 College st.

Director.

GEORGE J. BRUSH, (3 S. H.) 14 Trumbull st.

Professors,

ARRANGED IN THE ORDER OF THEIR GRADUATION.

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WILLIAM D. WHITNEY,
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JOHN E. CLARK,
Mathematics. (40 N. S. H.) 30 Trumbull st.

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Botany. (41 N. S. H.) 70 Sachem st.

CHARLES B. RICHARDS,
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Chemistry. (8 S. H.) 144 Edwards st.

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Civil Engineering. (34 N. S. H.) 328 Howard av.

CHARLES S. HASTINGS,
Physics. (39 N. S. H.) 191 Bradley st.

HENRY W. FARNAM,
Political Economy and History. 43 Hillhouse av.

RUSSELL H. CHITTENDEN,
Physiological Chemistry. (7 S. H.) 83 Trumbull st.

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Descriptive Geometry and Projection Drawing.
(53 N. S. H.) 14 Lincoln st.

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Kinematics and Machine Design. 19 Warren pl.

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Mineralogy. (2 P. M.) 14 S. H.

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Analytical Chemistry. 14 S. H.

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FELIX KLEEBERG,
Analytical Chemistry. 14 Orange st.

PERCY F. SMITH,
Mathematics. (46 N. S. H.) 13 Home pl.

CLERK.

LOUIS STADTMUELLER, 43 Whitney av.

JANITOR OF SHEFFIELD HALL.

ANTON PFEIFER, 55 Lock street.

JANITOR OF NORTH SHEFFIELD HALL.

GEORGE W. STODDARD, 82 Mansfield street.

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GRADUATE STUDENTS.

Louis Lawrence Barnum, LL.B, Yale University, 1886.	*Thompsonville, Conn.,*	16 S. H.
George Robert Carter, PH.B., Yale University, 1888.	*Honolulu, H. I.,*	43 College st.
Oliver Ellsworth Cramer, B.A., Augustana College, 1888.	*Rock Island, Ill.,*	20 Pearl st.
Charles Edward Curtis, PH.B., Yale University, 1888.	*New Haven, Conn.,*	138 Dwight st.
Orville Henry Drake, M.A., Bates College, 1884.	*Ashland, N. H.,*	55 Prospect st.
Henry Hays Ellis, PH.B., Yale University, 1888.	*Oxford, Me.,*	285 York st.
Oliver Cummings Farrington, M.S., Maine State College, 1888.	*Portland, Me.,*	55 Prospect st.
John Ellis Field, PH.B., Yale University, 1888.	*Denver, Col.,*	391 Temple st.
Matthew Griswold, Jr., PH.B., Yale University, 1888.	*Erie, Pa.,*	38 High st.
Alfred Hand, Jr., B.A., Yale University, 1888.	*Scranton, Pa.,*	128 High st.
Cyrus Field Judson, PH.B., Yale University, 1888.	*New York City.*	
Felix Kleeberg, PH.B., Yale University, 1889.	*New Haven, Conn.,*	14 Orange st.
Frank Dodge Leffingwell, B.A., Yale University, 1887.	*Montclair, N. J.,*	55 Prospect st.
Charles Norris, Jr., PH.B., Yale University, 1888.	*New York City,*	250 York st.
Selden Yale Osborn, PH.B, Yale University, 1888.	*New Haven, Conn.,*	131 Grove st.
William Ezra Roop, B.A., Western Maryland College, 1886.	*Westminster, Md.,*	125 Dwight st.
James Alward Seymour, PH.B., Yale University, 1885.	*Auburn, N. Y.,*	A.
Ernest Ellsworth Smith, PH.B., Yale University, 1888.	*New Haven, Conn.,*	1018 Chapel st.
Percy Franklin Smith, PH.B., Yale University, 1888.	*New Haven, Conn.,*	13 Home pl.
Fred Palmer Solley, B.A., Yale University, 1888.	*Orange, N. J.,*	116 w.
Erwin Starr Sperry, PH.B., Yale University, 1888.	*Ansonia, Conn.,*	Ansonia.
William Conquest Tucker, PH.B., Yale University, 1888.	*New York City,*	61 w.
Morgan Walcott, PH.B., Yale University, 1888.	*New York City,*	A.
Brownlee Robertson Ward, B.A., Yale University, 1888.	*New Haven, Conn.,*	138 Temple st.

GRADUATE STUDENTS, 24.

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SENIOR CLASS.

Arthur Chambers Alexander,	*Honolulu, H. I.*	38 High st.
William Belknap Allen,	*Pewee Valley, Ky.*	133 College st.
James Bradshaw Bailey,	*Harrisburg, Pa.*	43 College st.
William Bartlett Beckley,	*New Haven, Conn.*	300 Howard av.
William Dennison Breed,	*Cincinnati, O.*	68 w.
William Fances Breeze,	*San Francisco, Cal.*	114 High st.
George Tyler Burroughs, Jr.,	*Chicago, Ill.*	248 York st.
Henry Studley Burroughs,	*Chicago, Ill.*	248 York st.
Frank Arthur Busse,	*New Haven, Conn.*	3 Ridge st.
Perry Moore Caldwell,	*Wheeling, W. Va.*	36 Elm st.
Arthur Sanford Cheney,	*New Haven, Conn.*	45 Elm st
William Shinn Clawson,	*Woodstown, N. J.*	131 Grove st.
William Hillard Conyngham,	*Wilkes-Barre, Pa.*	43 College st.
Frank Marcus Cooper,	*Kingston, Pa.*	35 High st.
Louis Julius Curtis,	*Stamford, Conn.*	253 York st.
Arthur Herbert Day,	*New Haven, Conn.*	Grove st.
Edward Hangary Day,	*New Albany, Ind.*	297 George st.
Edwin Kirk Dillingham,	*New Orleans, La.*	133 College st.
Louis Coert DuBois,	*Hudson, N. Y.*	36 Elm st.
Frederick Howard Ellsworth,	*Hartford, Conn.*	1 Whalley av.
Harootum Enfiajian,	*Harpoot, Turkey,*	92 York sq.
Edward Everest,	*Newark, N. J.*	90 Wall st.
William Irving Ferrey,	*Pittsfield, Mass.*	35 High st.
Theron Rockwell Field,	*New York City,*	88 Wall st.
Lewis Brown Gawtry,	*New York City,*	43 College st.
George Frank Goodale,	*New Haven, Conn.*	6 Prospect pl.
Louis Montrose Haight,	*Alameda, Cal.*	90 Wall st.
Henry Pierce Hall,	*San Francisco, Cal.*	131 Grove st.
John Augustus Hartwell,	*Unionville, N. Y.*	128 Temple st.
Leland Howard,	*Hartford, Conn.*	43 College st.
Arthur Grant Huntington,	*Cleveland, O.*	132 Wall st.
Arthur Wiswell Jepson,	*New Haven, Conn.*	30 Grove st.
John Henry Klock, Jr.,	*New Haven, Conn.*	1201 Chapel st.
C. Carlton Lee,	*Cleveland, O.*	132 Wall st.
Eugene Lentilhon,	*New York City,*	71 w.
George Alfred Lund,	*West Stratford, Conn.*	297 York st.
David Lyman,	*Middlefield, Conn.*	391 Temple st.
Boynton Wells McFarland,	*New Haven, Conn.*	67 Mansfield st.
Frank Aloysius Maloney,	*New Haven, Conn.*	34 Ferry st.
Kingsley Walton Martin,	*Staten Island, N. Y.*	132 Wall st.
Ferris Jacobs Meigs,	*New York City,*	88 Wall st.
George Wellington Miles, Jr.,	*Milford, Conn.*	Milford.
John Raymond Mitchell,	*Franklin, Pa.*	126 Wall st.
Augustus René Moën,	*New York City,*	43 College st.
Edwin Morrison,	*Cincinnati, O.*	132 Wall st.
William Brewster Morrison,	*Willimantic, Conn.*	128 Temple st.

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William Belknap Newberry,	*New Haven, Conn.*	73 Whitney av.
Roger Samuel Newell,	*Bristol, Conn.*	88 Wall st.
Frank Lee Owen,	*Oakland, Cal.*	46 Elm st.
Gaius Foster Paddock,	*St. Louis, Mo.*	131 Grove st.
Kenyon Vickers Painter,	*Cleveland, O.*	155 Elm st.
William Henry Pierce,	*South Britain, Conn.*	22 Whalley av.
Edwin Read,	*Brooklyn, N. Y.*	131 Grove st.
Irwin Rew,	*Chicago, Ill.*	88 Wall st.
Henry Work Rianhard,	*New York City,*	43 College st.
Paul Skiff Robinson,	*New Haven, Conn.*	137 Edwards st.
Alfred Schwab,	*Chicago, Ill.*	72 w.
Paul Sheafer,	*Pottsville, Pa.*	105 Wall st.
Arthur Bertram Skelding,	*Riverside, Conn.*	383 Temple st.
George Jarvis Spencer,	*Old Saybrook, Conn.*	411 Temple st.
Charles Emerson Stone,	*Spencer, Mass.*	128 High st.
Danford Newton Barney Sturgis,	*New York City,*	68 w.
Lewis Hobart Sweetser,	*San Francisco, Cal.*	248 York st.
Henry Hutchins Sykes,	*New Haven, Conn.*	137 Wall st.
Oren Edward Taft,	*Chicago, Ill.*	152 Grove st.
Abraham Louis Thalheimer,	*New Haven, Conn.*	100 St. John st.
Charles Newman Traver,	*Hudson, N. Y.*	248 York st.
Clarence Beecher Twitchell,	*New Haven, Conn.*	68 Asylum st.
Harry Mighels Verrill,	*Portland, Me.*	90 Wall st.
Robert Taylor Wheeler,	*Jersey City, N. J.*	88 Wall st.
Guthrie Minor Wilson,	*Bardstown, Ky.*	297 George st.
Julius Vallette Wright,	*Cincinnati, O.*	131 Grove st.
William Charles Wurtenberg,	*Willink, N. Y.*	88 Wall st.

SENIORS, 73.

JUNIOR CLASS.

Philip Allen,	*Providence, R. I.*	133 College st.
John Allling, Jr.,	*Chicago, Ill.*	132 Wall st.
Cyrus Morgan Arnold,	*New York City,*	134 College st.
George Perkins Bissell, Jr.,	*Wilmington, Del.*	146 College st.
Theodore Whitney Blake,	*Whitneyville, Conn.*	29 Wall st.
George Henry Blakeslee,	*Schenectady, N. Y.*	107 Wall st.
Wendell Phillips Brown,	*Plainfield, Conn.*	59 Grove st.
Horace Ray Burritt,	*New Haven, Conn.*	54 Edwards st.
William Harper Butler,	*Olean, N. Y.*	248 York st.
Frederic Carter,	*Waterbury, Conn.*	26 Elm st.
Robert Lockwood Casement,	*Painesville, O.*	1010 Chapel st.
Horace Bushnell Cheney,	*South Manchester, Conn.*	90 High st.
John Platt Cheney,	*South Manchester, Conn.*	131 Grove st.
Ralph Roger Clapp,	*Pawtucket, R. I.*	395 Temple st.
Clarence Beverly Davison,	*New York City,*	43 College st.
Harry Goodyear Day,	*Seymour, Conn.*	1010 Chapel st.
Nelson Lloyd Deming,	*Danbury, Conn.*	88 Wall st.
Walter Dodge,	*Stamford, Conn.*	55 Trumbull st.

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Robert Metcalf Dodsworth,	*Los Angeles, Cal.*	55 Trumbull st.
Harrison Irwin Drummond,	*St. Louis, Mo.*	131 Grove st.
Julian DuBois,	*Hudson, N. Y.*	38 Elm st.
Alexander William Evans,	*New Haven, Conn.*	12 High st.
Willis Judson Fenn,	*Plymouth, Conn.*	395 Temple st.
Freeland Barney Gardner,	*Chicago, Ill.*	132 Wall st.
Ralph Schuyler Goodwin, Jr.,	*Thomaston, Conn.*	395 Temple st.
Neil Gray, Jr.,	*Oswego, N. Y.*	1010 Chapel st.
Everett Gallup Griggs,	*St. Paul, Minn.*	131 Grove st.
Lewis Winters Gunckel,	*Dayton, O.*	36 Elm st.
Charles Newton Gunn,	*New Haven, Conn.*	255 York st.
Joseph Barnard Hall,	*Hortford, Conn.*	36 Elm st.
Lawrence Heyworth,	*Chicago, Ill.*	43 College st.
Harry Dutton Holbrook,	*Utica, N. Y.*	107 Wall st.
Theodore Dudley Irwin,	*Albany, N. Y.*	88 Wall st.
Adrian Muller Isham,	*New York City,*	1010 Chapel st.
Walter Tracy Ives,	*Montreal, Canada,*	391 Temple st.
William Francis Judson,	*New York City,*	43 College st.
Elbridge Byron Keith,	*Chicago, Ill.*	132 Wall st.
William Matthew Kenna,	*New Haven, Conn.*	Selden House.
Charles Louis Kirschner,	*New Haven, Conn.*	94 Prospect st.
Harvey Merrill Lawson,	*Union, Conn.*	134 College st.
Franklin Lyman Lawton,	*Meriden, Conn.*	Meriden.
Oliver Smith Lyford, Jr.,	*Chicago, Ill.*	88 Wall st.
Herbert McBride,	*Cleveland, O.*	43 College st.
Frank Dunlevy McCaulley,	*New York City,*	131 Grove st.
John Carter Machale,	*Sawyer City, Pa.*	297 York st.
Henry Porter McKnight,	*Louisville, Ky.*	107 Wall st.
Campbell Emory McMichael,	*Philadelphia, Pa.*	43 College st.
Frederick James Mann,	*Utica, N. Y.*	126 High st.
William Crosby Marshall,	*Cromwell, Conn.*	65 Grove st.
James Moorhead Murdoch,	*Pittsburgh, Pa.*	131 Grove st.
John Stevens Murdock,	*Westbrook, Conn.*	7 Library st.
Paul Nash,	*Westport, Conn.*	59 Grove st.
Edgar Burr Northrup,	*Broadalbin, N. Y.*	248 York st.
Alfred Walling Ogden,	*Keyport, N. J.*	286 Norton st.
Charles Augustus Otis, Jr.,	*Cleveland, O.*	1010 Chapel st.
Robert Ellsworth Peck,	*New Haven, Conn.*	486 Elm st.
John Frederick Pennell,	*New Haven, Conn.*	109 High st.
John Conover Powell,	*Dayton, O.*	248 York st.
Frank Russell Rich,	*New Haven, Conn.*	369 Shelton av.
Charles Talbot Richmond,	*Providence, R. I.*	133 College st.
Walter Brooks Robinson,	*Chicago, Ill.*	1010 Chapel st.
William Sterling Roby,	*Rochester, N. Y.*	1010 Chapel st.
Charles Francis Rogers,	*New Canaan, Conn.*	43 College st.
Edwin Rowe, Jr.,	*New Haven, Conn.*	411 Orange st.
James Woodrow Ruthven,	*Scranton, Pa.*	36 Elm st.
Ernest Elisha Severy,	*Waterbury, Conn.*	393 Temple st.

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Chester Burdell Shepard,	*Middletown, Conn.*	65 w.
William Alexander Simms,	*Dayton, O.*	248 York st.
Walter Tuttle Spencer,	*Guilford, Conn.*	65 w.
Charles Bailey Spruce,	*Waterbury, Conn.*	86 w.
Frederic Clark Strong,	*Winsted, Conn.*	86 w.
John Clayton Tracy,	*Fair Haven, Conn.*	299 Center st., F. H.
Albert Milford Turner,	*Northfield, Conn.*	265 Orange st.
John McKee Verhoeff,	*Louisville, Ky.*	393 Temple st.
Edward Young Ware,	*St. Louis, Mo.*	7 Library st.
William Walker Weare,	*Chicago, Ill.*	310 Elm st.
Charles Spencer Wells,	*Southport, Conn.*	86 Whitney av.
Henry Lord Wheeler,	*Chicago, Ill.*	132 Wall st.
Frederick Wareham Williams,	*Norwich, Conn.*	131 Grove st.
George Cushing Worthington,	*Cleveland, O.*	36 Elm st.

JUNIORS, 80.

FRESHMAN CLASS.

William Adams, Jr.,	*Scarsdale, N. Y.*	289 Temple st.
Frederick Max Adler,	*New Haven, Conn.*	127 Greene st.
Colgate Baker, Jr.,	*Hiogo, Japan,*	7 Library st.
Harris Walton Baker,	*Springfield, Mass.*	1136 Chapel st.
Alfred Victor Barnes,	*Brooklyn, N. Y.*	29 High st.
Arthur George Beach,	*Bristol, Conn.*	192 York st.
Harry Cockill Beury,	*Shamokin, Pa.*	46 Elm st.
Willis James Black,	*Bridgeport, Conn.*	213 Crown st.
Burton Dickinson Blair,	*Collinsville, Conn.*	389 Temple st.
Arthur Eli Booth,	*Peace Dale, R. I.*	111 Dwight st.
William Henry Bronson,	*New York City,*	108 High st.
Harry Kilburn Brown,	*Denver, Col.*	242 York st.
Joseph Douglas Brown,	*New York City,*	44 Elm st.
Wendell Greene Brownson,	*New Canaan, Conn.*	318 Orange st.
Sterling Haight Bunnell,	*Stratford, Conn.*	213 Crown st.
Browne Caldwell,	*Pittsburgh, Pa.*	90 Wall st.
Robert Calhoun,	*Chicago, Ill.*	114 High st.
DeLancey Allen Cameron,	*Brooklyn, N. Y.*	389 Temple st.
Nehemiah Candee,	*Easton, Conn.*	386 Crown st.
Robert Hanna Carnahan,	*Fort Wayne, Ind.*	46 Elm st.
Henry Albert Carpenter,	*Willimantic, Conn.*	31½ Broadway.
Francis Allen Clark,	*Plantsville, Conn.*	70 Howe st.
Noyes Dwight Clark,	*Woodbridge, Conn.*	642 Elm st.
Robert Lewis Coleman,	*San Francisco, Cal.*	38 Elm st.
Lehman Adams Cooper,	*Hagerstown, Md.*	133 College st.
Homer Stile Cummings,	*New Haven, Conn.*	174 Whitney av.
Laurence Andrew Dodsworth,	*New York City,*	44 Elm st.
Frederick James Easterbrook,	*New Haven, Conn.*	82 York sq.
George Sherwood Eddy,	*Leavenworth, Kan.*	133 College st.
Robert France Elmer,	*New York City,*	55 Trumbull st.
Wyatt Collier Estes,	*Memphis, Tenn.*	106 Wall st.

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George Chandler Forrest,	*Hartford, Conn.*	133 College st.
Albert Francke,	*New York City,*	347 York st.
Eugene Duncan Funk,	*Shirley, Ill.*	289 York st.
Frank Hamilton Funk,	*Bloomington, Ill.*	289 York st.
Edward Everitt Gates,	*Indianapolis, Ind.*	53 Prospect st.
Simon Phillip Goodhart,	*New Haven, Conn.*	189 Wooster st.
Willis Blake Goodwin,	*Bangor, Me.*	128 Wall st.
Henry Whitmore Gregory,	*Darien, Conn.*	144 Olive st.
William Pierson Hamilton,	*New York City,*	130 Wall st.
Pearl Tenney Haskell,	*West Falmouth, Me.*	285 York st.
Frank Edwin Hawkes,	*Oxford, Me.*	285 York st.
David Alexander Hays,	*Johnstown, N. Y.*	389 Temple st.
Walter William Heffelfinger,	*Minneapolis, Minn.*	425 Temple st.
Edwin Guy Helm.	*Peru, Ind.*	133 College st.
John Williamson Herron, Jr.,	*Cincinnati, O.*	107 Wall st.
James Tracy Hill,	*Chicago, Ill.*	133 College st.
Robert Gibson Hilton,	*Newburgh, N. Y.*	238 York st.
Robert Massonneau Hoffman,	*Red Hook, N. Y.*	389 Temple st.
Thomas Osborn Horton,	*Peconic, N. Y.*	409 Temple st.
Robert Schuttler Hotz,	*Chicago, Ill.*	389 Temple st.
David Lynde Huntington,	*San Diego, Cal.*	219 York st.
Milton Cleaveland Isbell,	*Ansonia, Conn.*	Ansonia.
Theodore Caldwell Janeway,	*New York City,*	65 Grove st.
Frederick William Jones, Jr.,	*New York City,*	126 Wall st.
Walter Woodruff Keith,	*Chicago, Ill.*	70 Grove st.
James Hugh Kimball,	*Chicago, Ill.*	31 Trumbull st.
George Coburn Kohler,	*Akron, O.*	1179 Chapel st.
Augustus Frederick Kountze,	*Omaha, Nebr.*	130 Wall st.
George Tallman Ladd,	*New Haven, Conn.*	324 York st.
George Marcellus Landers, Jr.,	*New Britain, Conn.*	137 Wall st.
Walter William Law, Jr.,	*Yonkers, N. Y.*	395 Temple st.
Clifford Walter Leavenworth,	*Wallingford, Conn.*	35 High st.
Daniel Alden Loring, Jr.,	*Detroit, Mich.*	133 College st.
Charles Nassau Lowrie,	*Warriors Mark, Pa.*	395 Temple st.
George Eldredge McClellan,	*Woodstock, Conn.*	59 Grove st.
Harold Chauncey Mathews,	*New York City,*	391 Temple st.
David Magie Meeker,	*Newark, N. J.*	1142 Chapel st.
George Wylie Mercer,	*Omaha, Nebr.*	391 Temple st.
Harral Mulliken,	*Washington, D. C.*	310 Elm st.
Gustave Munzesheimer,	*New York City,*	223 York st.
Warren Bynner Nash,	*Brooklyn, N. Y.*	114 High st.
John Colwell Neale,	*Kittanning, Pa.*	629 Chapel st.
Nathaniel Read Norton,	*Brooklyn, N. Y.*	318 Orange st.
Gustave Osterweis,	*New Haven, Conn.*	301 Crown st.
James Allen Paramore,	*St. Louis, Mo.*	New Haven House.
Stanley Hawken Pearce,	*Denver, Col.*	109 Wall st.
Arthur Chapin Pease,	*Ellington, Conn.*	285 York st.
William Horace Pelton,	*Hartford, Conn.*	130 Wall st.

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George Henry Pinney,	*South Manchester, Conn.*	226 Crown st.
Edwin Tewksbury Porter,	*Eau Claire, Wisc.*	53 Prospect st.
George Nathaniel Prentiss,	*Watertown, Wisc.*	242 York st.
Alfred Helm Preston,	*Omaha, Nebr.*	391 Temple st.
Walter Grey Preston,	*Omaha, Nebr.*	391 Temple st.
Leavitt Sprague Rand,	*Minneapolis, Minn.*	25 Wall st.
Gardner Read,	*Brooklyn, N. Y.*	425 Temple st.
Harold Anthony Richmond,	*Providence, R. I.*	137 Wall st.
Fletcher Ritsinger,	*Indianapolis, Ind.*	53 Prospect st.
Charles Marcy Robinson,	*Middletown, Conn.*	90 Wall st.
Charles Farnham Rockwell,	*New York City,*	71 w.
Eugene Boutelle Sanger,	*Bangor, Me.*	238 York st.
Charles H. Saunders,	*Hartford, Conn.*	137 College st.
Ennis Newton Searles,	*New Haven, Conn.*	279 Sherman av.
John David Shattuck,	*Norwich, N. Y.*	409 Temple st.
Harry Hudson Shepard,	*New Haven, Conn.*	409 Orange st.
George Monroe Sidenberg,	*New York City,*	421 Temple st.
Edward Carlton Sisson,	*Binghamton, N. Y.*	146 College st.
George Milton Smith,	*Plantsville, Conn.*	70 Howe st.
Thomas Cullen Bryant Snell,	*New Haven, Conn.*	105 Wooster st.
Lewis Edwards Sparrow,	*Colchester, Conn.*	92 York sq.
George Pratt Starkweather,	*New Haven, Conn.*	N. H. Hospital.
Arthur Stein,	*Chicago, Ill.*	311 York st.
George Fetter Stickney,	*Louisville, Ky.*	393 Temple st.
Charles Ferris Sturtevant,	*Cleveland, O.*	107 Wall st.
Edward Owen Sutton,	*Springfield, Mass.*	83 Grove st.
Issa Tanimura,	*Tōkyō, Japan,*	39 Lynwood st.
Amasa Trowbridge,	*New Haven, Conn.*	685 Orange st.
Edward Van Ingen,	*Brooklyn, N. Y.*	425 Temple st.
Clark Greenwood Voorhees,	*New York City,*	104 Wall st.
Arvine Wales,	*Massillon, O.*	1179 Chapel st.
William Ernest Walker,	*Chicago, Ill.*	114 High st.
Robert Karl Wehner, Jr.,	*New Haven, Conn.*	1210 Chapel st.
Carl Frances Westerfield,	*San Francisco, Cal.*	150 College st.
Rudolph Michael Weyerhaeuser,	*Rock Island, Ill.*	407 Orange st.
Noah Ashley Whitney,	*Toledo, O.*	36 Wall st.
Henry Wick, Jr.,	*Cleveland, O.*	407 Orange st.
Aras James Williams,	*Utica, N. Y.*	393 Temple st.
Charles Morgan Wood,	*Dayton, O.*	389 Temple st.
George Waters Wood,	*Pittsburgh, Pa.*	7 Library st.
Pierre Jay Wurts,	*New Haven, Conn.*	65 Whitney av.

FRESHMEN, 120.

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SPECIAL STUDENTS NOT

Philip Danforth Armour, Jr.,
Tecumseh Sherman Clark,
Philip James Deering,
Louis Stanley Ferry,
George Dexter Gregory,
Alfred Stillé Ives,
John Kenneth Mackenzie,
William Strong Post,

SU

GRADUATES	.
SENIORS	.
JUNIORS	.
FRESHMEN	.
SPECIAL STUDENTS	.

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SHEFFIELD SCIENTIFIC SCHOOL.

OBJECTS.

The Sheffield Scientific School is devoted to instruction and researches in the mathematical, physical and natural sciences, with reference to the promotion and diffusion of science, and also to the preparation of young men for such pursuits as require especial proficiency in these departments of learning. It is one of the Departments of Yale University, like the law, medical, theological, and art schools, having its separate funds, buildings, teachers and regulations but governed by the Corporation of Yale College, which appoints the professors and confers the degrees. It is, in part, analogous to the academic department, or classical college, and, in part, to the professional schools.

The instruction is intended for two classes of students :—

I. Graduates of this or of other colleges, and other persons qualified for advanced or special scientific study.

II. Undergraduates who desire a training chiefly mathematical and scientific, in less part linguistic and literary, for higher scientific studies, or for various other occupations to which such training is suited.

HISTORY AND ORGANIZATION.

The school was commenced in 1847. In 1860, a convenient building and considerable endowment were given by Joseph E. Sheffield, Esq., of New Haven, whose name at the repeated request of the Corporation of Yale College, was afterward attached to the foundation. Mr. Sheffield afterward frequently and munificently increased his original gifts.

In 1863, by an act of the Connecticut Legislature, the national grant for the promotion of scientific education (under the congressional enactment of July, 1862), was given to this department of Yale University. Since that time, and especially since the autumn of 1868, numerous liberal gifts have been received from

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the citizens of New Haven, and from other gentlemen in Connecticut and New York, for the endowment of the School, and the increase of its collections.

The action of the State led to the designation by law of a State Board of Visitors, consisting of the Governor, Lieutenant-Governor, three senior Senators, and the Secretary of the State Board of Education; and this Board, with the Secretary of the Scientific School, is also the Board for the appointment of students to hold the State scholarships.

The Governing Board consists of the President of Yale University and the professors who are permanently attached to the School. There are several other instructors associated with them, a part of whom are connected with other departments of the University.

BUILDINGS AND APPARATUS.

The two buildings in which the work of instruction in the Scientific School is mainly carried on, are called Sheffield Hall and North Sheffield Hall; but instruction in Mineralogy, Geology, and Biology, including Zoology and Comparative Anatomy, is now given entirely in the Peabody Museum and Free Hand Drawing in the Art School. These buildings contain a large number of recitation and lecture rooms, a hall for public assemblies and lectures, chemical and metallurgical laboratories, besides studies for some of the professors, where their private technical libraries are kept.

The following is a summary statement of the collections belonging to the School:

1. Laboratories and Apparatus in Chemistry, Metallurgy, Physics, and Zoology.
2. Metallurgical Museum of Ores, Furnace Products, etc.
3. Agricultural Museum of Soils, Fertilizers, useful and injurious insects, etc.
4. Collections in Zoology.
5. Astronomical Observatory, with an equatorial telescope by Clark and Sons, of Cambridge, a meridian circle, etc.
6. A collection of Mechanical Apparatus, constituting the "Collier Cabinet."
7. Models in Architecture, Geometrical Drawing, Civil Engineering, Topographical Engineering and Mechanics; diagrams adapted to public lectures: instruments for field practice.
8. Maps and Charts, topographical, geological, hydrographical, etc.

The herbarium of Professor Brewer, and the astronomical instruments of Professor Lyman, are deposited in the buildings. Professor Eaton's herbarium, near at hand, is freely accessible. Students also have access to the various laboratories and collections in Natural Science in the Peabody Museum.

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Students are also admitted, under varying conditions, to the University and Society libraries, the College Reading Room, the School of the Fine Arts, and the Gymnasium.

THE LIBRARY.

The special technical library of the Scientific School consists of about five thousand volumes. Included in this is the "Hillhouse Mathematical Library" of twenty-four hundred volumes, collected during a long series of years by Dr. William Hillhouse, and in 1870 purchased and presented to the Institution by Mr. Sheffield. A catalogue of this collection forms a supplement to the Annual Report of the Governing Board of 1870. All the prominent scientific journals of this country and of Europe, together with the proceedings of foreign academies, and scientific societies, can be found either in this library or in the University Library to which students have access.

INSTRUCTION FOR GRADUATE AND SPECIAL STUDENTS.

Persons who have gone through undergraduate courses of study, here or elsewhere, may avail themselves of the facilities of the School for more special professional training in the physical sciences and their applications; gaining in one, two, or three years, the degree of BACHELOR OF PHILOSOPHY or, in two additional years of Engineering study, that of CIVIL ENGINEER or of MECHANICAL ENGINEER.

Or, engaging in studies of a less exclusively technical character, they may become candidates for the degree of DOCTOR OF PHILOSOPHY. The instruction in such cases will be adapted to the particular needs and capacities of each student, and may be combined with that given by the graduate instructors in other departments of the University. This degree is conferred upon those who, having already taken a Bachelor's degree, engage as students in the Department of Philosophy and the Arts for not less than two years in assiduous and careful study. It is not given upon examination to those whose studies are pursued elsewhere. The requirements for it will in some cases exact of the student more than two years of post-graduate labor, especially so, wherever the course of undergraduate study has been, as in the Scientific School, of less than four years. The candidate

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must pass a satisfactory final examination, and present a thesis giving evidence of high attainment in the branches of knowledge to which he has attended. A good knowledge of Latin, German and French will be required in all cases, unless, for some exceptional reason, the candidate be excused by the Faculty. The graduating fee is ten dollars.

Subjects likely to receive special attention are suggested as follows:

Professor DuBois, in the principles of thermodynamics, and utilization of heat as a source of power.

Professor Richards, in mechanical engineering.

Professor Hastings, in selected subjects in physics, and guidance in laboratory work.

Professor Brush and Professor S. L. Penfield, in the analysis and determination of mineral species, and in descriptive mineralogy.

Professor Johnson, in theoretical, analytical, and agricultural chemistry.

Professor Brewer, in agriculture and forest culture and in physical geography.

Professor Clark in definite integrals, differential equations, analytical mechanics, the theory of numerical approximation, with the method of least squares.

Professor Eaton, in structural and systematic botany, with reference to both flowering and cryptogamous plants.

Professor Verrill, and Professor Smith, in zoology, comparative anatomy, and geology.

Professor Chittenden, in physiological chemistry and experimental toxicology.

Professor H. L. Wells and Professor S. L. Penfield, Analytical Chemistry, including a systematic course in Qualitative Analysis; a systematic course in Quantitative Analysis, and such special branches of Quantitative Analysis as are applied to Mineralogy and various departments of Metallurgy.

The same courses of study are open, for a longer or shorter time, to graduate students who do not desire to become candidates for a degree.

Students who have taken the degree of Bachelor of Philosophy, may obtain the degree of Civil or of Mechanical Engineer at the end of two academical years, by pursuing the following higher course of study and professional training.

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The course of study for the degree of CIVIL ENGINEER will comprise—

1. Higher Calculus, Higher Geometry. Theory of Numerical Operations.
2. Analytical Mechanics. Mechanics applied to engineering.
3. A Course of Constructions and Designs. Projects.
4. Practical Astronomy, with use of Instruments, computations, etc.

The course will occupy one year.

To secure the requisite amount of professional knowledge and practise, the candidate will be required to furnish a comprehensive report of the results of an examination into the existing condition of some special line of constructive art; or to present proper evidence that he has had actual charge in the field, for several months, of construction or surveying parties, or held some responsible position deemed equivalent to this.

An elaborate design must also be submitted of some projected work of construction, based upon exact data obtained from careful surveys made by the candidate, and comprising all the requisite calculations and the necessary detailed drawings, and accompanied by full specifications of the work to be done and the requirements to be met by the contractor.

The fee for this degree is five dollars.

The course of study for the degree of MECHANICAL ENGINEER will comprise—

1. Higher Calculus, Higher Geometry. Theory of Numerical Operations.
2. General Principles of Dynamics (Analytical Mechanics), including special application of these Principles to Dynamic Problems.
3. Construction of Machines. Designs.
4. Preparation of theses on special subjects in Mechanical Engineering.

During the second year, candidates will be permitted to employ such portion of their time as may be deemed advisable or necessary in the examination of engineering works and manufacturing establishments, and may also have the privilege of entering upon professional practice, provided it is done with the knowledge and consent of the Professor of Mechanical Engineering, and under such circumstances as shall appear to him to be favorable to professional progress.

An elaborate thesis on some professional subject, with an original design, or project, accompanied by proper working drawings, will be required at the end of the second year.

The fee for this degree is five dollars.

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SPECIAL STUDENTS.—For the benefit of qualified, desire to pursue particular studies the obtaining of a degree, special or received in most of the departments of the in the Select Course or in the Freshman

It should be distinctly understood that not offered to persons who are incompet special studies pursued by the regular to aid those who, having received a suffi tion elsewhere, desire to increase thei branches.

INSTRUCTION FOR UNDERGRA

TERMS OF ADMISSION—Candidates mu years of age, and must bring satisfacto character from their former instructor persons.

For admission to the Freshman Class t thorough examination in the following su

English—including grammar, spelling, and composi Essentials of English Grammar, or an equivalent

History of the United States.

Geography.

Latin—(1) Simple exercises in translating English i *Latina*," Part i, is named as indicating the natur ment, and an acquaintance with it will be requir tute is offered.) (2) Cæsar—six books of the ((As advantageous substitutes for the last three bo three books of Virgil's Aeneid, or a similar amou

Arithmetic—Fundamental Operations, Least Comm Divisor, Common and Decimal Fractions, Denon Metric System of Weights and Measures; Perce count, and Commission; Proportion, Extracti Roots.

Algebra—Fundamental Operations, Fractions, Eq with one or several unknown quantities; Ineq Powers and Roots, including the theory of Expo an Entire Exponent, and the Transformation and tions of the Second Degree, Progressions, Cont and Combinations, the Doctrine of Limits, the N Indeterminate Coefficients, Fundamental Proper Interest and Annuities.

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Geometry—Plane, Solid, and Spherical; including fundamental notions of Symmetry, and examples of Loci and Maxima and Minima of Plane Figures,—so much, for example, as is contained in Newcomb's Geometry, exclusive of the chapters on the Ellipse, Hyperbola, and Parabola.

Trigonometry—Including the Analytical Theory of the Trigonometrical Functions and the usual formulæ; the Construction and Use of Trigonometrical Tables; and the Solution of Plane Triangles;—so much, for example, as is contained in the first six chapters of Newcomb's larger Trigonometry and in Arts. 75–78 of chapter viii, with the explanation of the first five tables in Newcomb's Five-figure Logarithmic and Trigonometric Tables, which are furnished at the examinations in New Haven.

While no entrance examination is held in the *History of England*, candidates for admission are urgently advised to make themselves as familiar as possible with that subject, as a knowledge of it is essential to the most successful prosecution of some of the studies of the course.

Candidates will be allowed the option of passing on the above-named subjects in two successive years. In such cases they must present themselves for examination at the June examination of the first year in the following subjects or parts of subjects: *History of the United States, Geography, Arithmetic, Plane Geometry, and Algebra to Quadratic Equations.*

In order to have this preliminary examination counted, candidates must pass satisfactorily on four of the subjects; and notice of the intention to divide the examination must be given to Professor George J. Brush, Director of the School, on or before June 15.

In his preparation in GEOMETRY the candidate should, as far as practicable, have suitable exercise in proving simple theorems and in solving simple problems for himself. It is important, too, that he should be accustomed to the numerical application of geometric principles, and especially to the prompt recollection and use of the elementary formulæ of mensuration. In TRIGONOMETRY he should be exercised in applying the usual formulæ to a variety of simple reductions and transformations, including the solution of trigonometrical equations. Readiness and accuracy in trigonometrical calculations are also of prime importance to the candidate. If the use of logarithms is postponed in his preparation till Trigonometry is taken up (which is by no means necessary or advisable), he should then have abundant application of them to all forms of calculation occurring in ordinary practice, as well as to those appearing in the solution of triangles. Finally, in all his calculations, he should study the art of neat and orderly arrangement.

In LATIN the student should have such continued training in parsing as shall make him thoroughly familia. with declensions and conjugations, and with the leading principles of syntax. To secure these results more effectually, the requirement has been adopted of simple exercises in translating English into Latin.

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As this course of exercises is designed solely as a preparation for reading, it should be begun at the earliest stage of Latin study. A very large proportion of the deficiencies in the Latin examination for several years past has been due to the neglect of the suggestions of this paragraph, and to the attempt to read a Latin author with totally inadequate grammatical preparation.

The examinations for admission in 1889 take place at North Sheffield Hall, on Thursday, Friday, and Saturday, June 27, 28, 29 (beginning at 9 A. M. on Thursday); and on Tuesday and Wednesday, September 17, 18 (beginning at 9 A. M. on Tuesday).

In general, examinations for admission to the Freshman Class of the *next* year can be held only in June and September as specified; if in any case sufficient reason exists for an exception to this rule, a special fee (not exceeding fifty dollars) will be charged.

In 1889, examinations (for the Freshman Class only) will also be held in Exeter, N. H., in Andover, Mass., in New York City, in Chicago, in Cincinnati, and in San Francisco (beginning on Thursday, June 27, at 9 A. M.), at places to be announced in local newspapers of the day previous. Candidates who propose to be present are requested to send their names to Professor George J. Brush, Director of the School, before June 15. A fee of five dollars will be charged for admission to the examinations outside of New Haven.

Candidates for advanced standing in the undergraduate classes are examined in addition to their preparatory studies, in those already pursued by the class which they wish to enter. No one can be admitted as a candidate for a degree, later than at the beginning of the Senior year.

COURSES OF INSTRUCTION, occupying three years, are arranged to suit the requirements of various classes of students. The first year's work is the same for all; for the last two years the instruction is chiefly arranged in Special Courses. The Special Courses most distinctly marked out are the following:

(*a.*) In Chemistry; (*b.*) In Civil Engineering;
(*c.*) In Mechanical Engineering;
(*d.*) In Agriculture; (*e.*) In Natural History;
(*f.*) In Biology preparatory to Medical studies;
(*g*) In studies preparatory to Mining and Metallurgy;
(*h.* In select studies preparatory to other higher studies.

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The arrangement of studies is indicated in the annexed scheme. A fuller statement of the methods and character of the instruction will be found below, p. 83. Unless otherwise specified, the number of hours given means hours per week.

FRESHMAN YEAR: INTRODUCTORY TO ALL THE COURSES.

FIRST TERM:—*German*—Whitney's Grammar and Reader, 3 hrs. *English*—Lounsbury's History of the English Language, 1 hr.; Exercises in composition. *Mathematics*—The Derivatives of Algebraic Functions; Fundamental Properties of Equations; Plane Analytical Geometry; 3 hrs. *Physics*—Recitations, 2 hrs., with experimental lectures, 2 hrs. *Chemistry*—Recitations, 2 hrs.; laboratory practice, 2 hrs. *Elementary Drawing*—Practical Lessons in the Art School, 3 hrs.

SECOND TERM:—*Language, Physics, and Chemistry*—as stated above. *Mathematics*—Plane Analytical Geometry, continued, 3 hrs. *Physical Geography*—8 lectures during the term. *Botany*—Gray's Lessons, 3 hrs. *Drawing*—Principles of Orthographic Projections; Isometric Drawing with application to drawing from models and structures, and isometric construction of objects from their orthographic projections; Projections of Shadows; Shading and tinting; Sections; Developments and Intersections of Surfaces; 4 hrs.

For the Junior and Senior years, the students select for themselves one of the following Courses.

(a.) IN CHEMISTRY.

JUNIOR YEAR.

FIRST TERM:—*Organic Chemistry*—Lectures and Recitations, 2 hrs. *Qualitative Analysis*—Recitations, 2 hrs.; Laboratory Practice, 20 hrs.; Blowpipe Practice and Determinative Mineralogy, 4 hrs. *German*—3 hrs. *French*—3 hrs.

SECOND TERM:—*Organic Chemistry*—Lectures and Recitations, 2 hrs. *Quantitative Analysis*—Laboratory Practice, 20 hrs.; Recitations, 2 hrs. *Mineralogy*—Blowpipe Analysis and determination of species, 4 hrs.; Lectures in Crystallography and Descriptive Mineralogy, 2 hrs. *French*—3 hrs. *German*—3 hrs.

SENIOR YEAR.

FIRST TERM:—*Organic and Theoretical Chemistry*—Recitations and Lectures 2 hrs. *Agricultural Chemistry*—Recitations (optional), 2 hrs. *Quantitative Analysis*—continued six weeks, 20 hrs. *Organic Chemistry*—Experimental work during the remainder of the term, 20 hrs. (optional). *Geology*—Dana's; Recitations, 3 hrs. *Zoology*—Lectures, 2 hrs. *French*—3 hrs.

SECOND TERM:—*Theoretical Chemistry*—continued, 2 hrs. *Zoology*—continued, 2 hrs. *Agricultural Chemistry*—(optional), 2 hrs. *Analytical Chemistry*—Analysis of Minerals and Technical Products, 20 hrs. *Assaying*—(optional). *Metallurgy*—Lectures (optional). *Geology*—Dana's, 3 hrs. *Mineralogy*—(optional). *French*—3 hrs., during Winter half-term.

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The Laboratory Practice of the second term of the Senior Year may be devoted to such special branches of Analytical or Organic Chemistry as the student may desire, or to original investigations in connection with theses.

(b.) IN CIVIL ENGINEERING:

JUNIOR YEAR:

FIRST TERM:—*Mathematics*—Analytical Geometry of Three Dimensions; Elements of the Theory of Functions; Differential Calculus, with applications to Geometry and Analysis; solution of Numerical Equations; 6 hrs. *Surveying*—Field work, 16 hrs. till November. *Drawing*—Descriptive Geometry, 6 hrs. from November. *German*—3 hrs. *French*—3 hrs.

SECOND TERM:—*Mathematics*—Integral Calculus with applications to Geometry: Rational Mechanics; 6 hrs. *Drawing*—Descriptive Geometry, concluded: Topographical; Practice in working drawings; 6 hrs. *Surveying*—Topographical and Rail Road curves, 16 hrs. *German*—3 hrs. *French*—3 hrs.

SENIOR YEAR:

FIRST TERM:—*Field Engineering*—Location of line of Railroad, setting out slope stake, calculation of earth work; Lectures on economic location; Office work; Henck's Field Book; 20 hrs. till November. *Civil Engineering*—Mecanics applied to Engineering; Resistance of Materials; Bridges and Roofs: Stone Cutting with Graphical Problems; 8 hrs. *Geology*—Dana's 3 hrs. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy, 4 hrs. *French*—3 hrs.

SECOND TERM:—*Civil Engineering*—Bridges and Roofs; Building Material; Stability of Arches and Walls; Foundations; 6 hrs. *Dynamics*—Principals of Mechanisms; Thermodynamics; Steam Engine; 5 hrs. *Hydraulics*—Hydraulics and Hydraulic Motors, 3 hrs. *Drawing*—Designing; Practical Problems; Specifications and Estimates; 12 hrs. *Spherical Trigonometry and Astronomy*—Practical Astronomy, with field work, 6 hrs. *Mineralogy*—continued during Winter half-term, 4 hrs. *Geology*—3 hrs. *French*—3 hrs. during Winter half-term.

(c.) IN MECHANICAL ENGINEERING:

JUNIOR YEAR:

FIRST TERM:—*Mathematics*—Analytical Geometry of Three Dimensions; Elements of the Theory of Functions; Differential Calculus, with applications to Geometry and Analysis; Solutions of Numerical Equations; 6 hrs. *Surveying*—Theory and Practice; 3 hrs. until November 1st. *Principles of Mechanism*—Kinematics, 1 hr. *Shop Visiting*—Study of Machine Details and Tools; 3 hrs., beginning when Surveying ends. *Drawing*—Descriptive Geometry, 3 hrs. *German*—3 hrs. *French*—3 hrs.

SECOND TERM:—*Mathematics*—Integral Calculus, with applications to Geometry: Rational Mechanics; 6 hrs. *Principles of Mechanism*—Applied Kinematics: Forms of Teeth of Wheels; Cams; Parallel Motions; Transmission of Power

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by Belts and Gearing, etc.; 1 hr. until Spring recess, then 2 hrs. *Shop Visiting*—continued, 3 hrs., until Spring recess. *Study of the Steam Engine*—2 hrs. after Spring recess. *Drawing*—Perspective and Shadows; Machine Elements; 3 hrs. *German*—3 hrs. *French*—3 hrs.

SENIOR YEAR:

FIRST TERM:—*Applied Mechanics*—Friction; Moment of Inertia; Centrifugal Force; Elasticity and Strength of Materials; Theory of Flexure and Torsion; Strains in Structures; Construction of Roofs and Bridges; Equilibrium and Pressure of Fluids; Theory of Flotation; Flow of Fluids in Pipes and Channels; Resistance of Ships; 9 hrs. *Machine Designing*—Practical Exercises in Designing Machine Details and Simple Machines, 12 hrs. *Study of the Steam Engine*—continued, 2 hrs. *Electricity* (optional)—Laboratory work, 3 hrs. *Visits of Inspection*—Examination of Machinery in operation; Reports of Visits. *French*—3 hrs.

SECOND TERM—*Applied Mechanics*—continued; Hydrodynamics; Theory of Water-Wheels and Turbines; 6 hrs. *Thermodynamics*—3 hrs. *Study of the Steam Boiler*—2 hrs. *Electricity* (optional)—Laboratory work, 3 hrs. Lectures, 2 hrs. *Machine Designing*—continued; advanced exercises in Preparing Designs and Working Drawings for Machinery: Estimates of Weight and Cost of Machinery; 12 hrs. *French*—3 hrs. during Winter half-term. *Thesis. Visits of Inspection and Reports.*

(d.) IN AGRICULTURE:

JUNIOR YEAR:

The course is identical with that in Chemistry, except that in the second term lectures in Crystallography and Descriptive Mineralogy are omitted, and in the Spring half-term Botany is substituted for Determinative Mineralogy.

SENIOR YEAR:

FIRST TERM:—*Agriculture*—Recitations, 2 hrs. *Agricultural Chemistry*—Recitations, 2 hrs. *Geology*—Recitations, 3 hrs. *Zoology*—Lectures, 2 hrs. *Meteorology*—Lectures, 2 hrs. *Botany*—Laboratory Practice, 5 hrs. *English*—Recitations, 2 hrs. *French*—Recitations, 3 hrs.

SECOND TERM:—*Agriculture*—Recitations or Lectures, 2 hrs. *Agricultural Chemistry*—Recitations, 2 hrs. *Physiology*—Recitations or Lectures, 2 hrs. *Geology*—Recitations, 3 hrs. *Zoology*—continued, 2 hrs. *English*—Recitations, 3 hrs. *Heredity and Stock-Breeding*—Lectures, 2 hrs. during Winter half-term. *Sanitary Science and Public Health*—Lectures, 2 hrs. Spring half-term. *French*, 3 hrs. during Winter half-term.

(e.) IN NATURAL HISTORY:

Either Mineralogy, Zoology, or Botany, may be made the principal laboratory study, some attention in each case being directed to the other branches of Natural History.

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JUNIOR YEAR:

FIRST TERM:—*Organic Chemistry*—Lectures and Recitations. *Qualitative Analysis*—Fresenius's; Laboratory Practice; Recitations. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy, 4 hrs. *Botany*—Gray's Manual, 3 hrs.; Laboratory Practice, 3 hrs. *German*—3 hrs. *French*—3 hrs.

SECOND TERM:—*Zoology*—Laboratory Practice, 6 to 12 hrs.; Recitations; Excursions (land and marine). *Botany*—Lectures; Laboratory Practice in the identification of Phænogamous Plants, 2 hrs. *Physiology*—Huxley's. *Embryology*—Lectures. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy, 4 hrs. Lectures in Crystallography and Descriptive Mineralogy, 2 hrs. *Physical Geography*. *German*—3 hrs. *French*—3 hrs.

SENIOR YEAR.

FIRST TERM:—*Geology*—Dana's, 3 hrs.; Excursions. *Zoology*—Laboratory Practice, 8 to 12 hrs.; Lectures, 2 hrs.; Recitation, 2 hrs.; Excursions. *Botany*—Laboratory Practice in the Examination of Microscopical Specimens, illustrative of Stem-structure and of the Anatomy of the higher Cryptogamous Plants, 5 hrs.; Excursions. *Meteorology*—Lectures, 2 hrs. *French*—3 hrs.

SECOND TERM:—*Geology*—Dana's, 3 hrs. *Anatomy of Vertebrates*—Huxley's, 2 hrs. *Zoology*—Laboratory Practice, 8 to 12 hrs.; Recitations, 2 hrs.; Lectures, 2 hrs. *Botany*—Herbarium Studies, especially in the Cryptogamous Orders; Botanical Literature; Essays in Descriptive Botany. *Sanitary Science*, *Laws of Heredity*, and *Principles of Breeding*—Lectures. *French*—3 hrs. during Winter half-term.

Besides the regular course of recitations and lectures on structural and systematic Zoology and Botany, and on special subjects, students are taught in the laboratories to prepare, arrange, and identify collections, to make dissections, to pursue investigations, and when sufficiently advanced, to describe genera and species in the language of science. For these purposes, large collections in Zoology belonging to the College are available, as are also the private botanical collections of Professor Eaton.

(f.) IN BIOLOGY PREPARATORY TO MEDICAL STUDIES:

JUNIOR YEAR:

FIRST TERM:—*Organic Chemistry*—Lectures and Recitations, 2 hrs. *Qualitative Analysis*—Fresenius's: Laboratory Practice, 20 hrs.; Recitations, 2 hrs. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy, 4 hrs. *German*—3 hrs. *French*—3 hrs.

SECOND TERM:—*Anatomy and Histology*—Laboratory Practice, 18 hrs.; Lectures and Recitations, 1 hr. *Physiology*—Huxley's; Recitations, 2 hrs. *Embryology*—8 Lectures during the term. *Organic Chemistry*—continued, 2 hrs. *Mineralogy*—continued through Winter half-term, 4 hrs. *Botany*—Lectures; Laboratory Practice in the identification of Phænogamous plants, 5 hrs. during Spring half-term; Excursions. *German*—3 hrs. *French*—3 hrs.

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SENIOR YEAR:

FIRST TERM:—*Physiological Chemistry*—Recitations and Lectures, 3 hrs.: Laboratory Practice, 13 hrs. *Organic and Theoretical Chemistry*—Lectures and Recitations, 2 hrs. *Zoology*—Lectures, 2 hrs. *Botany*—Laboratory Practice in the Preparation and Examination of Microscopical Specimens, illustrative of Stem-structure, and of the Anatomy of the higher Cryptogamous Plants, 5 hrs. *Geology*—Dana's, 3 hrs. *French*—3 hrs.

SECOND TERM: *Physiological Chemistry and Experimental Toxicology*—Illustrative Lectures, Recitations, and Laboratory Practice, 27 hrs. *Geology*—Dana's, 3 hrs. *Zoology*—continued, 2 hrs. Organic and Theoretical Chemistry continued until the recess. *Sanitary Science*—Lectures, 2 hrs. during Spring half-term. *Laws of Heredity and Principles of Breeding*—Lectures, 2 hrs. during Winter half-term. *French*—3 hrs. during Winter half-term.

(g.) IN STUDIES PREPARATORY TO MINING AND METALLURGY:

Young men desiring to become Mining Engineers can pursue the regular Course in Civil or Mechanical Engineering, and at its close can spend a fourth year in the study of Metallurgical Chemistry, Mineralogy, etc.

(h.) IN THE SELECT STUDIES PREPARATORY TO OTHER HIGHER STUDIES:

JUNIOR YEAR:

FIRST TERM:—*Mineralogy*—Blowpipe Analysis and Determinative Mineralogy, 8 hrs. *Astronomy*—Recitations, 4 hrs. *English*—Early English, 2 hrs. *History*—Green's Short History of the English People, 2 hrs. *French*—3 hrs. *German*—3 hrs.

SECOND TERM:—*Mineralogy*—Lectures; Laboratory work, 8 hrs. during Winter half-term. *Botany*—Lectures; Laboratory Practice in the identification of Phaenogamous Plants, 2 hrs. during Spring half-term. *Physical Geography*—4 hrs. during Winter half-term; Recitations from Guyot and Lectures. *English*—Chaucer, Bacon, Shakspere, 2 hrs. during Winter half-term, 3 hrs. during Spring half-term. *History*—Green's History, continued, 2 hrs. during Winter half-term, 4 hrs. during Spring half-term. *German*—3 hrs. *French*—3 hrs.

SENIOR YEAR:

FIRST TERM:—*Geology*—Recitations, 3 hrs.; Excursions. *Zoology*—Lectures, 2 hrs. *English*—Shakspere, 2 hrs. *Meteorology*—Lectures, 2 hrs. *Constitutional Law*—4 hrs. *French*—3 hrs.

SECOND TERM:—*Geology*—continued, 3 hrs. *Zoology*—continued, 2 hrs. during Winter half-term. *Meteorology*—Lectures, 2 hrs. during Winter half-term. *Sanitary Science*—Lectures, 2 hrs. during Winter half-term. *Political Economy*—Recitations, Exercises, and Lectures, 4 hrs. *English*—Shakspere, Milton, Dryden, Pope, Gray, and later authors, 3 hrs. *French*—3 hrs. during Winter half-term.

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Exercises in English Composition are required during the entire course from all the students. The preparation of graduating theses is among the duties of the Senior year.

Lectures on Military Science and Tactics are annually given by officers of the United States Army.

The following account of the various subjects specified in the above scheme will explain the character and aim of the instruction.

ELEMENTARY CHEMISTRY—The exercises in Elementary Chemistry consist in recitations from a text-book, and experiments by the students in the laboratory to illustrate statements in the book. The object of the laboratory work is to facilitate the study of the subject, and to train the students in manipulation and in the observation of chemical phenomena. Notes are required and students are questioned on the experiments. As the class is divided according to scholarship in Chemistry and Physics, opportunity is given to those who are most proficient to make rapid progress.

ANALYTICAL CHEMISTRY—*Qualitative and Quantitative*—This study is intended to serve two purposes. Analytical Chemistry is used by the advanced student as a means of investigation in scientific or technical researches. The beginner, however, derives from its study advantages of another kind. The knowledge of the properties of chemical compounds, the familiarity with chemical reactions gained by experience in the laboratory, and the development of the reasoning faculties by the application of this knowledge in analytical processes, enable the student to generalize and classify chemical phenomena and aid him to understand the more abstract theories of chemical philosophy. The method of instruction adopted is conformed to this view of the uses of the study. Text-books are used and recitations are required, but the more important part of both study and instruction is performed in the laboratory. In order to solve the problems which are there constantly presented, the student, aided by books and instructors, must learn both principles and their applications. The student, throughout his course in Analytical Chemistry, spends four consecutive hours in laboratory work during five days of the week. The laboratory, however, is kept open seven hours daily for the benefit of graduate students and others who desire to devote more time to this study.

Qualitative Analysis forms a part of the courses in Chemistry, Biology, Agriculture, and Natural History. Quantitative Analysis is one of the more important studies of the Senior year in the Chemical Course. It is also included to some extent in the Agricultural Course.

ORGANIC CHEMISTRY is taught by informal lectures and experimental illustrations as well as by text-book drill, a lesson from Richter's Organic Chemistry being given out for each instruction-hour. The class has two exercises weekly throughout three terms. The course is adapted to give a fairly complete outline of the subject and some familiarity with the more important bodies and classes of bodies.

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In addition to this, the Senior students in the Chemical Course can spend 20 hours per week during the latter half of the first term in experimental work in Organic Chemistry. This is intended to supplement the preceding course and at the same time to serve as a preliminary training for such students as desire to make a special study of Organic Chemistry.

Opportunity is also afforded for the carrying on of original investigations in this subject, either in connection with theses or as a part of the regular work in the case of advanced students.

PHYSIOLOGICAL CHEMISTRY and EXPERIMENTAL TOXICOLOGY—Physiological Chemistry is taught by laboratory exercises, illustrative lectures, and recitations. Each student is provided with a suitable working place in the laboratory, well equipped with all needed apparatus and material. The regular course of work, designed especially for Senior students in the Biological Course, extends throughout one year and embraces a thorough study of the chemical composition of the various tissues and fluids of the body, together with a study of the chemical and physiological processes of respiration, digestion, secretion, excretion, and nutrition in general.

Beginning with a study of the albuminous bodies, the experimental work extends through the epithelial, connective, contractile, and nerve tissues. Proceeding then to digestion, the various digestive fluids are studied, artificial digestions are made, and the several products of digestive action isolated and studied. The blood and urine are next considered, and students are taught to make both qualitative and quantitative analyses of the latter and to identify abnormal constituents. A portion of one term is also devoted to a study of the chemical reactions of the more important mineral and organic poisons, and their physiological action is determined experimentally. Students are also taught how to separate poisons from organic tissues and fluids, and to identify them, both by chemical and physiological reaction. During the latter half of the second term, Senior year, opportunity is afforded for the carrying on of original investigations on some selected subject in either physiological chemistry or toxicology, in connection with the preparation of graduating theses. The course of work is particularly recommended to students intending to enter upon a course of medical studies.

ANATOMY AND ELEMENTARY PHYSIOLOGY—The object sought in the instruction in Anatomy and Physiology, as taught during Junior year, is the manual and mental training of the student in the methods of investigation by which the facts and principles of these sciences have been established, and at the same time to give him a sufficient knowledge of their elements to enable him to pursue with profit the special studies of the Biological Course as a preparation for medical studies. With this end in view, five forenoons each week are given to laboratory work in Anatomy and Histology. The student, under the immediate supervision of the instructor, dissects specimens of a number of different animals, and is required to make careful sketches and records of his work; he also examines the different animal tissues with the microscope, makes microscopical preparations, and is taught the methods of anatomical and histological investigation. This work is reviewed each week by means of text-book and recitation, or by lecture and examination. The elements of Human Physiology are taught by text-book, recitations, and demonstrations. The physiology of digestion and nutrition is taught during Senior year in connection with Physiological Chemistry. During the

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last part of the term there is a short course of lectures on Embryology with special reference to Human Morphology.

GEOLOGY—The course in Geology includes recitations and oral instruction, extending through the entire year on alternate mornings. During the first half-year, the recitations are attended by the entire Senior Class, except those in the course in Mechanical Engineering. This part of the course includes Physical, Lithological and Dynamical Geology. These subjects are illustrated by diagrams and specimens. During the first term, each student is required to make a collection containing a specified number of the most important rocks and minerals, and to pass a thorough examination upon them at the end of the term; the object is to compel every student to become personally familiar with the appearance, as well as with the composition and other characters, of the rocks and minerals that are of most importance in Geology, as well as in the arts.

The last half of the year is devoted to Historical Geology and Palæontology. This part of the course is pursued by all the Seniors except those in the courses in Mechanical and Civil Engineering. Suitable collections of fossils are used to illustrate the subject.

Opportunities are afforded for optional geological excursions during the warmer months.

MINERALOGY—The instruction in Mineralogy is carried on by means of practical work in a laboratory especially fitted up for the purpose, and is intended to familiarize the student with the common minerals, attention being devoted especially to those which are of economic, geological, or scientific importance. To understand better the chemistry of the subject, the student is first made familiar with the simple chemical and blowpipe reactions useful in testing minerals, and applies this knowledge later to the determination of unknown species. The students have access to a labeled collection where they can study the properties of the minerals and make comparisons, and also to extensive unlabeled collections, arranged especially to give them practice and facility in the correct identification of minerals. In addition to the laboratory work, instruction is given in Crystallography, illustrated by a collection of models and natural crystals. The lectures in Descriptive Mineralogy to the more advanced students are illustrated by means of the extensive private collection of Professor Brush. The laboratory is provided with apparatus for the thorough chemical or physical investigation of minerals and with an extensive library to which the students have access. The laboratory is open seven hours each day to accommodate any who desire to devote more time and attention to the subject than is laid out in any of the prescribed courses.

ZOOLOGY—The instruction in Zoology includes a course of lectures on Systematic Zoology, Morphology, and Embryology, which are attended by all the Seniors except those in the courses in Mechanical and Civil Engineering. These lectures are generally given twice a week, and continue during about half the year. The students are required to keep careful notes of the lectures.

Students in the Natural History Course are also required to pursue a course of laboratory instruction during the second term of the Junior and all of the Senior year. This generally occupies from two to four days of each week. It includes dissections of various classes and orders of animals, with microscopic studies of the finer structures and of minute animal forms, as well as work in systematic Zoology.

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Special courses of recitations or lectures on particular subjects are also given when desirable.

BOTANY—The scheme of instruction provides for three successive courses of study, as either ending the study for the ordinary student, or introducing it for one who desires to become a professional botanist.

The first or elementary course, which is required of all the Freshmen, is designed to teach the nature of the visible organs of flowering plants, tracing the life history of vegetation from seed, through stem and root, leaves, branches, buds, blossoms and fruit, to seed again. The method consists mainly in the use of easy text-books, like Gray's Lessons, with whatever illustrations and explanations may be needed to secure the student's attention. The second course, coming the next year, is restricted to the sections in Biology, Natural History, Agriculture and Selected studies, and is intended to enable the student to recognize the chief natural orders of native plants, with the ability to identify the common species. The class meets two or three times a week in spring and summer, and is practiced in identifying plants, using Gray's Manual as a standard, and employing the ordinary simple dissecting microscope. At this point the instruction for the Select Course ceases: in the next fall term the work for the Courses in Biology, Natural History and Agriculture is entirely practical, books being used only for reference. Students begin with cutting thin sections of some common woody and herbaceous stems, and are shown how to prepare such sections for examination and for permanent preservation as microscopic objects. After acquiring some facility in microscopic manipulation, various parts of flowering plants are brought in for dissection and examination, and towards the close of the term some attention is given to Ferns, Mosses, and Algæ. This finishes the course for ordinary students; for those who may desire to prosecute the science professionally, the work is arranged to suit individual requirements, whether it be in the direction of Histology, or of Systematic Botany as applied to flowering plants, or to Ferns, Mosses, Hepatics, or Algæ.

AGRICULTURE—The special instruction in the science of Agriculture is by recitations and lectures, with such aids and appliances as are suited to the class-room. Besides Agricultural Chemistry, it includes a discussion of the cultivation of the staple field crops of the country; a production of live stock; theories of rural economy and systems of husbandry; the laws of heredity and principles of stock-breeding.

SANITARY SCIENCE—The lectures on this subject discuss the natural laws which govern the public health; their relation to the social habits and condition of communities; instruction in the use of mortuary statistics; epidemics and pestilences, with their relations to the prosperity of a community, and methods of control; the germ theory of disease and theory of disinfectants; the hygiene of private dwellings and public buildings; the relations of public health to water supply and to sanitary engineering; legislation relating to the public health and the methods of official sanitary administration.

MATHEMATICS—The Mathematical studies of the Freshman Year are pursued by all members of the class; those of the Junior Year by students in the Engineering courses and properly qualified Special Students who may choose them. During the latter year, in connection with the instruction briefly indicated in the

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scheme above [p. 46], a course of familiar lectures is given to supplement the ordinary class-room exercises.

PHYSICS—The object of the experimental lectures is not only to elucidate the subjects treated in the text-book employed, but also to extend the treatment of such subjects, and to introduce others where thought desirable. A considerable portion of the work of the year is the preparation for recitation on matter thus presented.

At the end of November, the Freshman class is redivided into three sections, according to capacity shown in the subjects of Chemistry and Physics. After this, although the experimental lectures will be attended as before by the class as a whole, the higher divisions will be able to pursue the studies more thoroughly.

The facilities of the Physical Laboratory will be extended to such graduate students and seniors as may desire them.

Course in Advanced Physics—A course of two lectures per week, beginning in January, is supplemented by laboratory work. The earlier portion of the time is devoted to the theory of observation and the method of least squares. The course is optional to all who have a command of the calculus.

CIVIL ENGINEERING—The object of this course is to give a thorough preparation, first of all, in the principles of the various sciences involved, and afterwards, as extensive practice in the application of these principles as the time at disposal, the ability of the students, and the facilities and plant permit.

Under the first head are included such subjects as Mathematics, Physics, Mechanics, Thermodynamics, Astronomy, Geology, Mineralogy, Chemistry, and Botany; and under the second head, Drawing, Surveying, Strength and Properties of Materials, and Design and Construction of various kinds, such as Bridges, Roofs, Foundations, Arches, Retaining Walls, Dams, Water Works, Railroads, Improvement of Rivers and Harbors, Sewerage and Drainage, Water Motors, etc.

The first division includes Civil Engineering as a Science, the other Civil Engineering as an Art. The ground covered by the second is of almost indefinite extent. Here, by a careful selection of practical examples, such as occur in engineering practice, the application of principles is illustrated, and together with the analytical or algebraic methods, the student is also instructed in practical graphic solutions, wherever such solutions present a special value. Much time is devoted to geodetic operations and to surveying in the field. Instruction is given in the practical operations connected with the reconnaisance, location, and surveying of roads, canals, and railroads, such as setting out, cross-sectioning, setting grade stakes, calculation of earth work, etc. Thorough instruction is given in drawing and designs, the construction of working drawings, the principles of designing as applied to bridges, roofs, etc.

The instruction is by means of practical exercises, lectures, and recitations, so combined as to develop so far as possible the mental powers of the student. Visits of inspection are made at suitable intervals to private and public works of engineering interest.

The entire course requires five years, three years of undergraduate and two of graduate instruction; and a Thesis of merit upon some approved subject, accompanied by designs and estimates, is required upon the completion of the course, as also at the end of the first three years. Examinations are also held at the end of every term and year.

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In what follows, such details are given as may be of interest to those who contemplate taking the course.

Mathematics—6 hours weekly, Junior Year, both terms. See Synopsis of Course.

French and German—Students in this course take in the Junior Year the regular studies of the Junior Class in both German and French, 3 hours each. In the Senior Year, French is continued, 3 hours during the Winter half-term.

Drawing and Descriptive Geometry—Drawing is begun at once in the first term of Freshman Year. under the charge of the Street Professor of Drawing in the Art School, and includes practice in free hand drawing. In the second term, under the Instructor in Instrumental Drawing, the students take isometric drawing with application to drawing from models and structures by measurement, shading. tinting, conventional use of colors, principles of orthographic projections, and practice in making simple working drawings. 4 hours both terms.

The Drawing of Junior Year, 3 hours both terms, includes Descriptive Geometry, the drawing of structures from measurement, and elements of design for simple structures. The instruction is by recitations, lectures, practical exercises and models, and is under the charge of the Instructor in Instrumental Drawing and the Professor and Instructor in Civil Engineering. Included in the work of this year is also the mapping of surveying field notes.

In the Senior Year, the drawing consists of the mapping of the surveys of that year, and the designing of structures and finished drawings, designs and estimates, under the charge of the Professor and Instructor in Civil Engineering, 6 hours both terms.

Surveying and Field Engineering.—The instruction in the field occupies about 20 hours for six or more weeks in both terms of Junior and Senior Year. The exercises at these times are so arranged as to secure as much consecutive time as possible in the field. In Junior Year, the use and adjustments of the instruments are learned and practice surveys made, together with recitations and lectures upon surveying operations and methods of keeping field notes. Levels are run, surveys made, plotted, and checked; blue print copies of drawings made, the use of compass, level and transit acquired. In the second term of Junior Year, land and topographical surveys are made and railroad curves run.

In the first term of Senior Year, a line of railroad is located and set out from a contour map previously obtained, grades and curves established and set out, and computations made. The theory of the economic location is taught by lectures and recitations in connection with the field work. The work is arranged so that each student has sufficient practice in all the various operations. The textbooks used are Gillespie and Johnson's works, Henck's Field Book, Gore's Elements of Geodesy, and Merriman's Theory of Least Squares. The course is under the charge of the Professor and Instructor in Civil Engineering, aided by several assistants.

Mechanics of Engineering—Senior Year, 6 to 8 hours, both terms. The textbooks of Weisbach, 1st and 2d volumes, are used in connection with lectures and solution of practical problems in illustration of the various topics. The course includes thorough instruction in the strength of materials, the stability of foundations, retaining walls, dams and embankments, and masonry arches, by lectures and graphic methods. Questions of hydraulics, water supply, and measurement of discharge, receive attention, and the theory and construction of water motors.

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A course in Thermodynamics with application to air and steam engines is also included.

Construction and Design—Senior Year, 6 hours both terms. A thorough course is given in the determination of stresses and the detailed design of roofs, bridges, etc., with working drawings, specifications, and estimates. Visits of inspection are made, and recitations and lectures held in connection with the work in the drawing room.

Astronomy—A course is given under the charge of the Professor in Astronomy, 6 hours, second term of Senior Year, including practical work and the use of the sextant and transit in determining time, latitude, and azimuth.

Geology—This course occupies 3 hours up to the middle of the second term of Senior Year.

Mineralogy—This course, under the Instructor in Mineralogy, occupies three hours up to the middle of the second term in Senior Year.

A course of lectures on the theory of electricity and its applications, by the Professor of Physics, is open to students in this department, and can be taken as a part of the preparation for a graduate course in the higher branches of electrical science.

MECHANICAL ENGINEERING—The objects aimed at in the plan of instruction in this course are, to give to the student a thorough training in elementary and advanced Mathematics and Physics, and their application to the Science of Construction; to make him familiar with the general principles of Engineering and with the practical details of mechanical construction through which these principles are made useful; and to enable him ultimately in beginning the work of his profession to bring to bear upon it a well balanced store of theoretical and practical knowledge, and a mind trained in correct habits of thought and work.

The complete course covers five years, three of which are spent in undergraduate study, and two in a graduate course, a portion of which may be spent in actual practical work. The subjects and methods of instruction in the undergraduate course are as follows:—

Mathematics—See synopsis, page 46.

French and German—Students take in the Junior year the regular studies of the Junior Class in both French and German. In the Senior year, French is continued during the Winter half-term.

Surveying—A short course in Surveying comprises lectures on methods of surveying and the construction and use of instruments, also practice in field work in the use of the level and transit, city surveying, establishing grades and laying out buildings.

Shop Visiting divides the time equally with Drawing in the Junior year until the Spring Recess. The student, accompanied by the instructor, is employed in studying machinery in use and in process of construction in different machine shops in the city. He is required to make satisfactory, carefully dimensioned sketches, from measurements taken by himself, of the complete machines and their parts, and to describe the tools and mechanical operations used in producing the simpler pieces.

Drawing—Descriptive Geometry is taught in the drawing room by lectures and recitations, and by exercises at the drawing board, where the problems are solved graphically by the student. Instruction in *drawing Machine Elements* is given in

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the Junior year. Models and cartoons showing examples of approved practice are used by the instructor, who also gives personal attention to each student's work at the board as it progresses.

Principles of Mechanism—This is a course in theoretical and applied Kinematics. Instruction is by text-books and lectures illustrated by diagrams and models, an extensive collection of which belongs to the School and is accessible to the student.

Steam Engine—Recitations and lectures in this subject begin in the Junior year, after the Spring Recess. They relate to the structural details of engines and to the mechanical principles involved in their working. The subject is continued in the first term of Senior year, when particular attention is directed to various kinds of valve gear, the governor, the fly-wheel, balancing, and the effect of the weight of the reciprocating parts. In the second term of Senior year, the study of *Steam Boilers* takes the place of that of Engines.

Indicator Practice—In the Senior year, the student is afforded opportunities to apply the indicator to various engines in operation, and has practice in reading indicator cards and measuring them by the planimeter. He is taught to detect such defects in the engines as are shown by the cards.

Applied Mechanics—In this course lectures, recitations, and exercises in the solution of practical problems, relate to the topics specified under this head in scheme on page 46.

Thermodynamics—Recitations and lectures on the mechanical theory of heat and its application to hot-air engines, gas engines, and the steam engine.

Machine Design—The course in this subject consists chiefly in practical exercises at the drawing board, and partly in lectures on the functions of machines and the mechanical principles which are applied in determining the proportions of machinery. The student, under the guidance of an experienced instructor, is employed in making complete working drawings of machines, many examples of which are in the drawing rooms and the basements of the school. He does not copy the examples, but is required to change the dimensions and in many cases to alter the design, and is ultimately taught to make partly new designs of important machinery, such as cranes, yacht engines, machine tools, boilers, etc. The discipline the student receives is such as he would obtain in the drawing office of an engineering establishment, while he is also carefully instructed in the theory of the subjects he deals with, and in the practical bearing of all his work.

In the Senior year, several excursions are made by the class, accompanied by one or more instructors, to neighboring manufacturing and engineering centers, where large manufactories, pumping works, ocean steamers, etc., are visited. Full notes must be taken, and a satisfactory written report upon the machinery examined is required of the student.

Thesis—Before graduating, the student must present a satisfactory thesis on some subject approved by the professor in charge of the department of Mechanical Engineering.

A course of lectures on the theory of Electricity and its applications is open to students in this department, and these lectures can be taken as a part of the preparation for a graduate course in the higher branches of electrical science.

ASTRONOMY—Students in the Select Course receive instructions in Astronomy during Junior year, first term, four hours per week.

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Students of Civil Engineering during the second term of their Senior year have six recitations per week, and also practical experience in the determinations of time, azimuths, latitude, longitude, etc.

ENGLISH—The course is designed to give the student acquaintance with the great representative writers of the various epochs. A history of the language is one of the studies of the Freshman year; and after that year the study of the language is made entirely subordinate to that of the literature. During the first term of Junior year, however, extracts from Early English authors are read, and Early English grammar studied, so as to familiarize the student with the inflections then in use and the distinctions existing between the leading dialects. It is the aim of this term's work to give such knowledge of forms, and to some extent of words, that the student will be able to read at sight any Early English author whose writings do not involve special difficulties of language or vocabulary.

With the second term, the regular study of English literature proper begins with Chaucer; and for the rest of the course till the end of Senior year the following authors are read: Bacon, Shakespere, Milton, Dryden, Pope, Gray, Goldsmith, and later writers. Those mentioned in the lists are always studied, but other authors not named are also taken up, the course varying somewhat in different years. In all cases complete works of a writer are studied, not extracts; as for instance several of Chaucer's Tales, and several of the plays of Shakespere. The authors are taken up in chronological order, and the literary history of the time is likewise carried on in connection with the great representative writers of each period.

GERMAN—The aim in this department is to give such a knowledge of facts and principles as shall qualify the student as rapidly as possible to use the language for such various purposes as his special needs may require, and particularly to facilitate the use of German treatises in his later special studies. To accomplish this, the course consists of the combination of the study of systematic German grammar with a complementary and progressive course of oral translation from English into German, the latter being designed for the double purpose of increasing the command of grammatical principles, and through the establishment of a habit of ready and accurate expression, of laying the foundation for future colloquial use of the language. In connection with the foregoing, it is attempted to introduce the student to as many different styles and as many forms of composition as the time allows. For this purpose the reading matter is in general selected from readers and collections prepared for the use of schools in Germany, and characterized by the number and variety of their extracts, thus enabling the instructor to select pieces that illustrate one another and to avoid similar lines of reading with successive classes. Constant attention is paid during a portion of the course to English affinities, to analogies in the formation of English and German abstract terms, to the commoner rhetorical resemblances and differences, to the details of arrangement in German sentences, and the development of secondary from primary significations of words.

In view of the shortness of the course there is no attempt to secure any considerable acquaintance with German literature. A body of representative pieces of lyric poetry, however, is made the basis of careful literary study, with special

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attention to poetic diction and variety of metrical form. Memorizing German poems is practised to some extent as a class exercise, as also translations of dictated literal versions of simple pieces into German verse, in accordance with prescribed rhythm and sequence of rhyme.

Occasionally, when the proficiency of a class allows it, an advanced division is organized, which is thus enabled to read a much larger amount of matter and to pursue more critical methods. The attention of such a division is sometimes given for a few months to extracts treating of leading events in German history, with a collateral course of German historical poetry, the selections being made so as to be mutally illustrative. Historical poems not contained in the text-books are often furnished by dictation.

During the last few weeks of the course, there is an attempt to initiate the student into the art of rapid and intelligent, though uncritical reading, dispensing largely with dictionary and grammar and aiming to form independent habits of observation and induction. For this purpose recourse is had to entertaining novels.

In general, it is the endeavor, while aiming primarily and constantly at acquiring a working knowledge of contemporary German, to combine habitually scientific and empirical methods, to enforce correct notions as to the nature of language, to secure incidentally some of the most important disciplinary results of elementary linguistic study, and to give some conception, by suggestive questions and occasional statements, of the various special directions which a more extended and advanced course would necessarily take.

The time alloted to the subject is three hours a week during the Freshman and Junior year.

Regular text-books: Whitney's German Grammar; Whitney's German Dictionary; Ahn's Exercises, or Eysenbach's German Exercises.

FRENCH—To avoid repetition, it will suffice to state that much the same course is pursued in French as above detailed for the German, and on like principles. The three weekly exercises extend through the entire Junior, and most of the Senior year, based on a systematic review of the essential elements as exhibited in Whitney's French Grammar, supplemented by Ahn for the more practical part. In the Junior year, a wide extent of reading is insisted on, beginning with the simpler novels, such as "Le Conscrit," "L'Ami Fritz," "La Petite Fadette," etc., through a scale of diversified vocabulary by which at last sight-reading of such matter as is more appropriate to the department may be profitably entertained. The practical or conversational course runs along parallel with the more systematic study of the language.

In the second year, the aim is to familiarize the student with practical terms and expressions of a scientific cast, rather than with the purely literary language. Hence, practical works, such as books of travel and Maxime Du Camp's Paris, ses Organes, ses Fonctions et sa Vie, especially those chapters describing the railways, the sewers, the Seine, the street-lighting, etc., have seemed best adapted to the general object in view.

HISTORY—The greater part of the work is carried on by means of recitations, Green's Short History of the English People being used as a text-book. The students are also required to look up special topics, and to give the results of

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their studies to the class: the books used for this purpose are drawn from a small historical library in the class-room. The location of places is enforced by the use of outline maps which the students are required to fill in. Particular attention is given to the history of institutions and to the constitutional and economic growth of the country.

POLITICAL ECONOMY—In the beginning of the course, an effort is made to familiarize the student with the fundamental principles of Economics and more particularly to train them in economic reasoning. More difficult problems are then taken up and discussed, and special topics are assigned to the class for investigation. A small library has been provided, which contains a number of copies of each of the principal authorities, in order that the students may be able to familiarize themselves somewhat with the literature of the subject, without expense to themselves.

TUITION CHARGES.

The charge for tuition for undergraduate students is $150 per year, payable $55 at the beginning of the first and second terms, and $40 at the middle of the second term. An additional charge of $5 a year is made to each student for the use of the College Reading Room and Gymnasium, which is payable at the beginning of the first term, making the total charge for that term $60. The student in the Chemical course has an additional charge of $70 per annum for chemicals and use of apparatus. He also supplies himself at his own expense with gas, flasks, crucibles, etc., the cost of which should not exceed $10 per term. A fee of $5 is charged members of the Freshman Class for chemicals and materials used in their laboratory practice, and the same fee is required from all (except Chemical students) who take practical exercises in Blowpipe Analysis and Determinative Mineralogy. A fee of $5 a term is also charged to students in the Zoological and Anatomical Laboratories, for materials and use of instruments.

For graduate students the charge for tuition is one hundred dollars per year.

CHURCH SITTINGS.

Free sittings for students in this department of Yale University are provided as follows: in the Center Church (Congregational); in the Trinity (Episcopal); and in the First Methodist Church.

Those who prefer to pay for a sitting for one year, more or less, in the churches above mentioned, or in any other church of

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any denomination, will be aided on application to the Secretary of the School.

Sittings in the Gallery of the College Chapel are free as heretofore to the students of this department.

DEGREES.

Students of this department, on the recommendation of the Governing Board, are admitted by the Corporation of Yale College to the following degrees. They are thus conferred :

1. Bachelor of Philosophy; on those who complete any of the three-years courses of study, passing all the examinations in a satisfactory manner, and presenting a graduation thesis.

The fee for graduation as Bachelor of Philosophy, including the fee for Triennial Catalogues, Commencement Dinners, etc., is $10; unless the person taking the degree is also an academical graduate, when it is but $5.

2. Civil Engineer and Mechanical Engineer: The requirements of this degree are stated on pages 39–41.

Doctor of Philosophy: The requirements of this degree are stated on pages 39–40.

TERMS AND VACATIONS.

The next academic year begins Thursday, September 20, 1889. For length of terms and vacations, see Calendar, p. 24.

ANNOUNCEMENT IN RESPECT TO STATE STUDENTS.

The scholarships established in this School in consequence of the bestowal upon it of the Congressional grants are designed to aid young men who are in need of pecuniary assistance in fitting themselves for agricultural and mechanical pursuits of life. All applicants must be citizens of Connecticut. In case there are more applicants than vacancies, candidates will be preferred who have lost a parent in the military or naval service of the United States, and next to these such as are most in need of pecuniary assistance; and the appointments will be distributed as far as practicable among the several counties in proportion to their population. The appointing Board for the current year, consisting of the Board of Visitors for the State and the Secretary of the School, will meet on June 25, 1889, and at or about the same

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time in the year 1890, due notice of which will be given by publication in every county in the State. All applications should be made previous to that time. Blank forms for application will be sent, when requested, by Professor GEORGE J. BRUSH, Secretary of the Appointing Board.

ANNIVERSARY.

The Anniversary of the School is held on Monday of the Commencement week of Yale University, when selections from the graduation theses are publicly read. The degrees are publicly conferred by the President and Fellows of Yale University on Commencement Day.

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APPENDIX.

ENTRANCE EXAMINATION PAPERS.

The following are the papers for 1888, upon which applicants for admission were examined at the June and September examinations.

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ARITHMETIC.

JUNE, 1888.

1. Find the factors and the greatest common divisor of 4815, 4905 and 5085.

2. Find the product of 25·3784 and 12·567 to two places of decimals.

3. Divide 287·1 by 3300.

4. The velocity of a body is 40 miles per hour, what is it expressed in feet per second?

5. If a man traveling uniformly, 7 hours per day, goes 455 miles in 26 days, how far can he go in 20 days, traveling 9 hours per day, at the same rate per hour as before?

6. A sold two horses (which he had previously purchased) for $200 each. On one of them he made a profit of $33\frac{1}{3}$ per cent.; on the other he incurred a loss of 20 per cent. Did he gain or lose in the transaction? And what did each horse cost him?

7. Extract the cube root of 3 to two places of decimals.

8. Reduce approximately 20 kilometers to miles and 20 kilograms to pounds avoirdupois.

ARITHMETIC.

SEPTEMBER, 1888.

1. Find the prime factors of 2310.

2. Find the greatest common divisor and the least common multiple of 1417 and 1469.

3. Find the value of $\frac{4}{7}$ of $\left(\frac{3\frac{1}{3}}{7} + \frac{2}{10\frac{1}{2}} - \frac{5}{18}\right)$

4. Divide 0.0002548 by 0.0364.

5. What per cent. of $2,142 is 25 per cent. of $2,856?

6. If you have a note of $1000 payable in 60 days, discounted at a bank at 6 per cent., what sum will you receive?

7. Extract the square root of 177 to three places of decimals.

8. About what is the value of the meter in inches? Of the liter in liquid quarts? Of the gram in grains?

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PLANE GEOMETRY.

JUNE, 1888.

[NOTE.—State at the head of your paper what text-book you have studied on the subject and to what extent.]

1. If, when a straight line crosses two straight lines, the alternate interior angles are equal, the two straight lines are parallel.

2. The radius perpendicular to a chord of a circle bisects the chord and the arc subtended by it.

3. The sum of the squares upon the two diagonals of a parallelogram is equal to the sum of the squares upon the four sides.

4. To divide a straight line internally into two segments which shall be to each other as two given straight lines.

5. State the methods for inscribing in a circle: (*a*) a regular decagon, (*b*) a regular pentagon, (*c*) a regular hexagon.

6. Of all plane figures having the same perimeter, what one has the greatest area?

SOLID AND SPHERICAL GEOMETRY.

JUNE, 1888.

[NOTE.—State at the head of your paper what text-book you have studied on the subject and to what extent.]

1. All lines perpendicular to another line at the same point lie in the same plane.

2. If each of two planes is perpendicular to a third plane, their line of intersection is also perpendicular to that third plane.

3. The sum of the angles of a spherical triangle is greater than two, and less than six, right angles.

4. Calculate the surface and volume of a sphere whose radius is one foot to four decimal places.

5. Calculate the area of a triangle on the preceding sphere whose angles are 90°, 75°, and 60°.

GEOMETRY.

SEPTEMBER, 1888.

[NOTE.—State at the head of your paper what text-book you have studied on the subject and to what extent.]

1. From a point outside a straight line only one perpendicular can be drawn to the line, and this perpendicular is the shortest distance from the point to the line.

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2. If two secants be drawn from a point outside a circle, the angle between them is measured by half the difference of the intercepted arcs.

3. Given an equilateral triangle circumscribed about a circle whose radius is R, to express its altitude, and the length of either of its equal sides, in terms of R; also, to compare its area with the area of the circle.

4. To construct a parallelogram equivalent to a given square, and having the sum of its base and altitude equal to a given line.

5. If two planes be perpendicular to the same straight line they are parallel or coincident.

6. The sum of the face angles of any convex polyhedral angle is less than four right angles.

7. Compare the areas of two mutually equiangular spherical triangles, the one on a sphere of radius 1, the other on a sphere of radius 2.

8. Compare the volume of a sphere whose radius is R with that of a cone whose base is a great circle of the sphere and whose altitude is R.

ALGEBRA TO QUADRATICS.

JUNE, 1888.

NOTE.—State at the head of your paper what text-book you have studied on the subject and to what extent.]

1. Simplify $ma-[nb+(pb-c)-qc+ma-(nb-\overline{c-pb})]$

2. Resolve the following expressions into factors: x^3+27; x^4-16; $a^4b^4-6a^2b^2+9a^2$; $a^{\frac{3}{4}}-b^{\frac{3}{4}}$.

3. Reduce the fraction $\frac{5x^2+4x-1}{20x^2+21x-5}$ to its lowest terms.

4. Given $\frac{x+ab}{b^2}-\frac{b^2-x}{a^2b}=\frac{x-b}{a^2}-\frac{ab-x}{b^2}$, to find x.

5. Given $(a-b)x+(a+b)y=c$ and $(a^2-b^2)(x+y)=n$, to find x and y.

6. Expand $(a^2-\frac{1}{2}b)^5$ by the binomial formula.

7. Simplify the following expressions: 1. $\left(\frac{a^2b^{-3}}{c^{-3}}\right)^6$.

2. $\sqrt{a^3b}\times\sqrt{ab^3}$. 3. $\sqrt{20}+\sqrt{45}+\sqrt{\frac{1}{5}}$. 4. $\sqrt[3]{2a}\times\sqrt{3b}$.

5. $\sqrt[3]{8a^6}$.

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ALGEBRA FROM QUADRATICS.

JUNE, 1888.

[NOTE.—State at the head of your paper what text-book you have studied on the subject and to what extent.]

1. Solve the equation $mqx^2-mnx+pqx=np$.

2. Solve the equation $\frac{1-ax}{1+ax}\left(\frac{1+bx}{1-bx}\right)^{\frac{1}{2}}=1$.

3. Determine the roots of $x(x^2-4)+(x-2)=0$.

4. Given $\frac{1}{x}+\frac{1}{y}=a$ and $\frac{1}{x^2}+\frac{1}{y^2}=b$ to find the value of x and y.

5. In how many different ways may seven persons be seated at a table?

6. In a system of twenty lines lying in the same plane, no two of which are parallel and no three of which pass through the same point, how many points will there be where two lines intersect?

7. A person puts out p dollars every year to accumulate at compound interest. What will be the amount of the accumulation at the end of n years, the interest being compounded annually and the interest of one dollar for one year being r?

ALGEBRA.

SEPTEMBER, 1888.

[NOTE.—State at the head of your paper what text-book you have studied on the subject and to what extent.]

1. Reduce the following expressions to their simplest equivalents:

(*a*) $\frac{x^2-9x+20}{x^2-6x}\times\frac{x^2-13x+42}{x^2-5x}$. (*b*) $\frac{a^4-x^4}{a^2-2ax+x^2}\div\frac{a^2x+x^2}{a^2-x^2}$.

2. Given $(a+b)x-(a-b)y=4ab$,
and $(a-b)x+(a+b)y=2(a^2-b^2)$, to find x and y.

3. Show that $x^3+1>x^2+x$ for all values of $x>-1$, except $x=1$.

4. Show that, if $a:b=p:q$,
then $a^2+b^2:\frac{a^2}{a+b}=p^2+q^2:\frac{p^2}{p+q}$.

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5. Simplify, (*a*) $(2ax^3y^{\frac{3}{4}})^2$. (*b*) $\sqrt{4a^3b^4c^6}$. (*c*) $\sqrt{125}$.

(*d*) $\frac{1}{3}x^{\frac{3}{5}} \cdot 6x^{\frac{3}{5}}$. (*e*) $\frac{3}{14}\left(\frac{2}{3}\right)^{\frac{1}{3}} \div \frac{3}{21}\left(\frac{9}{4}\right)^{\frac{1}{3}}$. (*f*) $\frac{7}{3}\frac{\sqrt{48}}{\sqrt{27}}$.

6. Expand $(a^2-a^{-2})^3$ and $(2x+y)^5$.

7. Solve the equation $x - \frac{x^3-8}{x^3+5} = 2$.

8. Solve the equation $[(x-2)^3-x]^2-(x-2]^2 = 88-(x-2)$.

9. Out of m Democrats and n Republicans how many different committees can be formed consisting of 2 Democrats and 3 Republicans?

10. Develop $\frac{1+2x}{1-x-x^2}$ into a series of ascending powers of x.

TRIGONOMETRY.

JUNE, 1888.

[NOTE.—State what text-book you have studied on the subject and to what extent.]

1. Find how many degrees there are in an arc whose radius is one foot, and whose length is 0·1 ft.

2. Show (*a*) $\sin(-\alpha) = -\sin\alpha$. (*b*) $\sin(\pi-\alpha) = -\sin(\pi+\alpha)$
(*c*) $\tan(\frac{3}{2}\pi+\alpha) = -\tan(\frac{3}{2}\pi+\alpha)$.

3. Given $\sin\alpha = 0{\cdot}1$ to find $\cos\alpha$, $\tan\alpha$, $\cot\alpha$, $\sec\alpha$, $\sin 2\alpha$ and $\cos 2\alpha$.

4. Given $\tan\alpha = 0{\cdot}1$ to find $\tan 2\alpha$.

5. Show that $\sin\left(\frac{\pi}{3}+x\right) - \sin\left(\frac{\pi}{3}-x\right) = \sin x$.

6. Given two sides of a triangle $a = 575$, $b = 425$ and the angle α opposite the former $= 125° 30'$, to find the remaining parts of the triangle.

7. The sine of a certain angle of a triangle is 0·67559 and its cosine is −0·73728; find the angle.

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TRIGONOMETRY.

SEPTEMBER, 1888.

[NOTE.—State what text-book you have studied on the subject and to what extent.]

1. Find the length of an arc of 90° in a circle whose radius is one foot.

2. Give the algebraic signs of the sine, tangent and secant of the following angles $\frac{\pi}{5}, -\frac{\pi}{5}, -\frac{4\pi}{5}, -\frac{4\pi}{5}$.

3. Given $\cos \alpha = 0.6$, to find $\cos(-\alpha)$, $\sec \alpha$, $\sin \alpha$, $\operatorname{cosec}(-\alpha)$, $\tan \alpha$, $\cot \alpha$, $\sin 2\alpha$, $\tan 2\alpha$.

4. Prove that, if $1 = \left(\frac{\sin \alpha}{\sin \beta}\right)^2 + (\cos \alpha \cos \gamma)^2$;

$$\text{then } \sin \gamma = \frac{\tan \alpha}{\tan \beta}.$$

5. Given $\sin(x + \alpha) + \cos(x + \alpha) = \sin(x - \alpha) + \cos(x + \alpha)$, to find x.

6. Find the angles of a triangle ABC when $A = 10° 30'$, and $5\,AB = 8AC$.

ENGLISH GRAMMAR.

JUNE, 1888.

1. Parse the following sentence:

Into the contest that was then raging, he a King's son, threw himself with all the partisanship of an irresponsible subject.

2. Give the principal parts of the verbs, *see*, *hate*, *send*, *cost*, *sing* and *thrive*. State to what conjugation each belongs and why it belongs to it.

3. What is the rule for the agreement of the relative with its antecedent?

CAESAR.

JUNE 28, 1888.

I. *Translate as literally as possible:*

1. Persuadent Rauracis et Tulingis et *Latobrigis, finitimis*, uti, eodem usi *consilio*, oppidis suis vicisque exustis, *una* cum iis pro-

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ficiscantur; Boiosque, qui trans Rhenum incoluerant et in agrum Noricum transierant Noreiamque oppugnarant, receptos ad se socios sibi adsciscunt.

2. Caesar equitatu praemisso subsequebatur omnibus *copiis;* sed ratio ordoque agminis aliter se habebat, ac Belgae ad Nervios detulerant. Nam quod ad hostes appropinquabat, *consuetudine* sua Caesar sex legiones expeditas ducebat; post eas totius exercitus impedimenta collocarat: inde duae legiones, quae proxime conscriptae erant, totum agmen claudebant *praesidio*que *impedimentis* erant.

3. Quod postquam barbari *fieri* animadverterunt, expugnatis compluribus navibus, quum *ei rei* nullum reperiretur auxilium, *fuga* salutem petere contenderunt; ac jam conversis in eam partem navibus, quo ventus ferebat, tanta subito malacia ac tranquillitas exstitit, ut se ex loco movere non possent.

4. Hostes proelio superati, simul atque se ex fuga *receperunt*, statim ad Caesarem legatos de pace miserunt, obsides *daturos*, quaeque *imperasset* facturos sese, *polliciti* sunt. Una cum his legatis Commius Atrebas venit, quem supra demonstraveram a Caesare in Britanniam praemissum.

5. At tanta militum virtus atque ea praesentia animi fuit, ut quum undique flamma *torrerentur* maximaque telorum multitudine *premerentur*, suaque omnia impedimenta atque omnes fortunas conflagrare *intelligerent*, non modo demigrandi causa de vallo decederet nemo, sed paene ne *respiceret* quidem quisquam, ac tum omnes acerrime fortissimeque pugnarent.

6. Ejus rei multas afferunt causas; ne assidua consuetudine capti studium belli gerendi agricultura commutent; ne latos fines parare *studeant* potentioresque humiliores possessionibus *expellant*; ne accuratius ad frigora atque aestus vitandos *aedificent;* ne qua oriatur pecuniae cupiditas, qua ex re factiones dissensionesque *nascuntur*.

II. *Grammatical questions, supplementary to the paper on Latin Grammar:*

1. State the construction of all italicized words in passages 1, 2 and 3.

2. Give the principal parts of all italicized words in passages 4, 5 and 6.

3. Quote in full from the above text an example of indirect statement and re-write it so as to make it direct.

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CAESAR.

SEPTEMBER 18, 1888.

I. *Translate as literally as possible:*

1. Ubi jam se ad eam rem *paratos* esse arbitrati sunt, oppida sua omnia *numero* ad duodecim, vicos ad quadringentos, reliqua privata aedificia incendunt; frumentum omne, praeterquam *quod* secum portaturi erant, comburunt, ut domum reditionis spe sublata, paratiores ad omnia *pericula* subeunda essent.

2. Quum se illi identidem in silvas ad suos reciperent ac rursus ex silva in nostros *impetum* facerent neque nostri *longius*, quam quem ad finem porrecta loca aperta pertinebant, *cedentes* insequi auderent; interim legiones sex, quae primae venerant, *opere* dimenso castra munire coeperunt.

3. Nam quum omnis juventus, omnes etiam gravioris *aetatis* in quibus aliquid *consilii* aut dignitatis fuit, *eo* convenerant, tum *navium* quod ubique fuerat, unum in locum coegerant; quibus amissis, reliqui neque quo se reciperent quemadmodum oppida defenderent, habebant. Itaque se suaque omnia Caesari dediderunt.

4. Caesar *questus*, quod quum ultro in continentem legatis missis pacem ab se *petissent*, bellum sine causa intulissent, ignoscere imprudentiae dixit obsidesque imperavit; quorum illi partem statim *dederunt*, partem ex longinquioribus locis *arcessitam* paucis diebus sese daturos dixerunt.

5. Paulum quidem intermissa flamma et quodam loco turri *adacta* et contingente vallum, tertiae cohortis centuriones ex eo, quo *stabant*, loco recesserunt suosque omnes removerunt; nutu vocibusque hostes, si *introire* vellent, vocare coeperunt, quorum progredi *ausus* est nemo.

6. Civitatibus maxima laus est quam latissimas circum se vastatis finibus solitudines habere. Hoc proprium virtutis existimant, *expulsos* agris finitimos *cedere*, neque quemquam prope audere *consistere*; simul hoc se fore tutiores arbitrantur, repentinae incursionis timore *sublato*.

II. *Grammatical questions, supplementary to the paper on Latin Grammar:*

1. State the construction of all italicized words in passages 1, 2 and 3.

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2. Give the principal parts of all italicized words in passages 4, 5 and 6.

3. Quote in full from the above text an example of indirect statement and re-write it so as to make it direct.

LATIN. (EXERCISES AND GRAMMAR).

JUNE 28, 1888.

Latin. (*Exercises and Grammar.*)

I. *Translate into Latin:*

1. Despatches[1] are immediately[2] sent[3] to[4] Caesar by Cicero.
2. Cicero immediately sends despatches to Caesar.
3. Despatches will be sent Caesar by Cicero.
4. Cicero says,[5] he will send despatches to Caesar.
5. (*Rewrite sentence* 4 *and substitute direct for indirect statement.*)
6. Cicero says, "I have sent despatches to Caesar."
7. (*Rewrite sentence* 6, *and substitute indirect for direct statement.*)
8. Despatches having been sent to Caesar, Cicero erected[6] many[7] towers.[8]
9. Caesar says (that) Cicero erected many towers.
10. Caesar says (that) many towers were erected by Cicero.

[1] litterae.
[2] confestim.
[3] mittĕre.
[4] ad.
[5] dicĕre.
[6] excitāre.
[7] multus.
[8] turris (*fem.*)

II. *Latin Grammar.*

1. Decline *castra, civis, tempus, iter, facilis, audax.*
2. Decline *is, qui, nullus, iste.*
3. Compare *audax, facilis, summus, acriter.*
4. Write the synopsis, active and passive, of *mittĕre* (*misi, missum*) and *docēre* (*docui, doctum*).
5. Enumerate all the uses you know of the dative case.

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LATIN. (EXERCISES AND GRAMMAR).

SEPTEMBER 18, 1888.

I. *Translate into Latin:*

1. Labienus stationed[1] the baggage[2] on[3] a hillock.[4]

2. The baggage had been stationed by Labienus on a hillock.

3. Labienus will send[5] the baggage in advance.[5]

4. The baggage will be sent-in-advance[5] and be stationed on a hillock.

5. Labienus said, "Soldiers,[6] you hold[7] the enemy[8] in a disadvantageous[9] place."[10]

6. Labienus said the soldiers held the enmey in a disadvantageous place.

7. (*Rewrite sentence* 6, *and substitute direct for indirect statement.*

8. Labienus, having sent the baggage in advance and stationed (it) on a hillock (N. B. *Use ablative absolute*), faced about[11] toward[12] the enemy.

[1] collocāre. [2] impedimenta. [3] in. [4] tumulus. [5] praemittĕre. [6] miles. [7] tenēre. [8] hostis. [9] iniquus. [10] locus. [11] signa convertĕre. [12] ad.

II. *Latin Grammar.*

1. Decline *dux*, *consul*, *equitatus*, *eques*, *incredibilis.*

2. Decline *is*, *idem*, *ullus.*

3. Compare *similis*, *melior*, *ultimus.*

4. Write the synopsis, active and passive, of *collocāre* and *scribĕre* (*scripsi*, *scriptum*).

5. Enumerate all the uses you know of the accusative case.

GEOGRAPHY.

JUNE, 1888.

1. Bound the State of Ohio; give the names and situations of three cities in the State.

2. Bound Russia; what is its capital and how is it situated? Give the names and situation of two other cities in this country.

3. What States touch the eastern bank of the Mississippi River? What cities are on the eastern bank and what States are they in?

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4. Where does the River Indus rise, what is its course, where does it empty, what country is it in?

5. What is a strait? Where is the Strait of Gibraltar? What water does it connect, what lands or countries does it separate? Give any other facts about it.

6. Where are the following cities: Buenos Ayres, Cairo, Cleveland, Cologne, Los Angeles, Providence, Trenton?

7. Where are the Hawaiian Islands? What is their chief city? To go there from here, what would be your route, by land and sea, and from what port would you sail?

GEOGRAPHY.

SEPTEMBER, 1888.

1. Bound the State of Virginia; name two rivers in the State or on its borders; give the names and situation of two cities in the State.

2. Bound France; give the names of two rivers in the country, describe their course and tell where they empty; give the names and situation of two cities in the country.

3. What states and provinces touch Lake Erie? What are the names and situations of the chief cities on its shores?

4. Where does the river Ganges rise, what is its course, what country is it in? Give any other facts about it.

5. Where are the following cities: Athens, Buffalo, Detroit, Edinburgh, Galveston, Havana, Sidney, Worcester?

6. Describe Behring's Strait; where is it, what waters does it connect, what lands does it separate and to what countries do they belong?

7. Where are the Bermuda Islands and how would you reach them from Cincinnati?

HISTORY OF THE UNITED STATES.

JUNE, 1888.

1. Give an account of the voyages of Frobisher, Gilbert, and Raleigh.

2. Describe the settlement of the colony of New York, and show the origin of its present name.

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3. Give the causes of, and the chief events in, the French and Indian war.

4. State the principal reasons for the revolt of the colonies.

5. Describe the leading events in the administration of President Polk.

6. What were the political parties in 1860?

N. B.—The dates are to be given with every question.

HISTORY OF THE UNITED STATES.

SEPTEMBER, 1888.

1. Give an account of the principal discoveries in America before 1550.

2. Explain the characteristics of royal, proprietary, and charter colonies.

3. Describe the proceedings of the Stamp Act Congress.

4. Give an account of the battles of Trenton, Brandywine, and Yorktown.

5. State the principal events in the administration of President Jackson.

6. Give the terms of the Compromise of 1850.

N. B.—The dates are to be given with every question.

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The Annual Report will be sent regularly to all graduates who may express the desire to receive it, and who furnish their addresses for the purpose. It is desirable that any change of address should be communicated by the first of January of each year.

For Circulars and other information, address

PROFESSOR G. J. BRUSH,

NEW HAVEN, CONN.

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TWENTY-THIRD REPORT

OF THE

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OF

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TWENTY-THIRD REPORT

OF THE

SHEFFIELD SCIENTIFIC SCHOOL

OF

YALE UNIVERSITY,

1889-90.

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STATE BOARD OF VISITORS,

CONSTITUTING, WITH THE SECRETARY OF THE SCHOOL, THE BOARD FOR THE APPOINTMENT OF STATE STUDENTS.

Governor.

HIS EXCELLENCY MORGAN G. BULKELEY, Hartford.

Lieutenant-Governor.

HIS HONOR SAMUEL E. MERWIN, New Haven.

State Senators.

HON. E. S. CLEVELAND, Hartford.
HON. JAMES GRAHAM, New Haven.
HON. O. VINCENT COFFIN, Middletown.

Secretary of State Board of Education.

CHARLES D. HINE.

Secretary and Treasurer of the School.

GEORGE J. BRUSH.

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REPORT

OF THE

STATE BOARD OF VISITORS.

To the General Assembly of the State of Connecticut:

In pursuance of the Act providing for the appointment of the Board of Visitors of the Sheffield Scientific School, I have the honor to report, that the Board have visited the School, inspected its equipment, and investigated its methods and facilities for instruction, and cheerfully commend the needs of the School as presented in the 23d Report of the Governing Board, which is herewith transmitted, and commended to your careful and intelligent consideration.

MORGAN G. BULKELEY,
Chairman.

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BIENNIAL STATEMENT

OF THE

GOVERNING BOARD.

In presenting their regular Biennial Report the Governing Board of the Sheffield Scientific School can hardly fail to call attention in the first place to the rapid increase in the number of its students. This is the most noticeable fact in the history of the last three years. In the academic year, 1888–9, the total number in attendance was 305. In the following year it rose to 343. In the present year it has reached 381.

In one sense this is a most gratifying tribute to the success of the efforts made by the Governing Board to keep the institution in the front rank of those which are devoted to the furtherance of scientific education. Its students, as might be expected, come largely from Connecticut. But it also draws them from the most remote States and Territories, and draws them in constantly increasing numbers. This is as satisfactory evidence as can be given that the advantages furnished by the school are coming to be more and more widely appreciated in all parts of the country.

While this, however, is in many respects gratifying, it has its unfortunate side. The increasing number of students puts more and more to the severest test the resources of the school both in the matter of equipment and instruction. This pressure has been steadily felt for years, but it is more plainly felt now than ever before. The buildings once thought ample to accommodate students for a long period beyond the present time are proving utterly inadequate to meet the demands made upon them. More rooms and larger rooms, further increase of laboratories, both in size and number, and additional buildings are imperatively required in order that the school shall keep pace with the numerous excellent institutions of the same character that are scattered throughout the country. The conversion of the Sheffield man-

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sion into a biological laboratory—an account of which will be found later—relieved for but a short time the pressure upon the chemical department. The rapid increase in the number of students speedily filled all the places made vacant by this transfer, and the Governing Board will be again speedily confronted with the same problem of how to provide for the proper instruction of students with the crowded accommodations now at their disposal. Though the past ten years have witnessed the reception of several valuable benefactions, these gifts are far from obviating

The Necessity of Increased Endowments.

It is to be borne in mind that with much inferior resources the Sheffield Scientific School has a much larger body of students in attendance than many of the older institutions of the country. In fact, comparatively few equal it in this particular. In the other New England colleges, outside of Boston, Cambridge and New Haven, it has in this respect no rivals. It has, for instance, a larger body of students than either Amherst or Williams, or Brown University or the undergraduate departments of Dartmouth, the four institutions which come the nearest to it in point of numbers. Yet in many respects it lacks the facilities for imparting effective instruction which those colleges in one way or another possess. It is hardly necessary to say to intelligent men that education is always expensive, and the higher the grade, the more expensive it becomes. Still it is only those, even among educated men, who have paid special attention to the subject that have any adequate conception of its necessary costliness. The Sheffield Scientific School is one of the three or four Land-grant colleges which has never received any appropriations from the State in which it is situated. Several of its sister institutions have received from such sources aid to the extent of hundreds of thousands of dollars, in the past, and are likely to receive still more in the future. The Governing Board of the Sheffield Scientific School have never desired any appropriation, have never asked for it, nor do they find any fault with the policy which is averse to granting it. Its growth in numbers and in reputation must be due in the future as it has been in the past to the generous interest taken in it by those who appreciate its work, and not to any assistance or aid that it will receive directly from the State. It was the munificent gift of more than a million of dollars from the

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benefactor from whom it receives its name, coupled with the privilege of using the great collections of Yale University, that has enabled it to take its place among the foremost institutions of the country that are devoted to the development of scientific education.

The position that has been gained it is desirable both for the credit of the institution and of the State that it should retain. But to do so, it must have additional facilities speedily. There is not only immediate necessity of more rooms and larger rooms to accommodate the increasing numbers, but also an increase in the teaching force for this same purpose. But there is one thing in particular to which it is necessary again to call attention. There is the most pressing need of a new building for the department of Civil and Mechanical Engineering, which should include Mechanical and Physical Laboratories, with facilities for practical instruction in Electro-Technics. The constantly increasing attention paid to the subject of electricity, and the development it is steadily undergoing render this a matter of the utmost immediate importance, especially in a State like Connecticut in which manufacturing interests occupy so prominent a position and are destined, in the near future, to occupy one even more prominent. It is here that the lack of sufficient facilities is now specially felt. Whatever means are offered to secure them will be utilized to the full extent of which they are capable. But it is important to make the fact prominent at the outset that a building for the purpose designed, and amply equipped for its special work, will cost, at least, one hundred and fifty thousand dollars. In addition to this its running expenses will involve an expenditure of seven or eight thousand dollars a year. However large these sums may appear, they are small compared with the establishments for the same purpose that are put up in Europe and are beginning to be put up in this country. It is to be hoped that the pressing need of a building of this character will be borne in mind by the graduates and friends of the institution, who recognize the necessity of properly fitting men to deal successfully with this new department of scientific study, which has now come so rapidly to the front.

Addition to the Funds.

The resources of the school have during the past two years however, met with considerable increase. Mrs. Sheffield, who

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had always been one of the warmest friends of the institution, which bears her husband's name, died on April 21, 1889. By her death the Trustees of the school came into possession of productive real estate, to the value of $75,000, in which she had had a life interest. That same year Mrs. Henry Farnam made a generous contribution of the sum of $2,000 for current income, which she has repeated the present year, making $4,000 in all.

The Governing Board also acknowledge the reception of a gift of $20,000 bequeathed them by the late James E. English, formerly Governor of the State. The duties of Mr. English as Governor compelled him to make an examination of the character and management of the school. As a result he became warmly interested in it, and remaining during his life one of its staunchest and most earnest friends. In a period when it was in financial straits he generously contributed $5,000 to its support, and the additional sum of $20,000, he left in his will for the purpose of endowing the chair of Mathematics.

Gifts.

The following gifts to the department of Mechanical Engineering are gratefully acknowledged.

From Mr. James A. Seymour, (class of 1885), of the firm of McIntosh, Seymour & Co., Auburn, N. Y., an Automatic Vertical Steam Engine, of four-horse power.

From the Walker Manufacturing Company of Cleveland, Ohio, a set of twelve large framed photographs of heavy machinery.

While the courtesy of many manufacturing establishments in the State in allowing students occasional access to inspect their operations is fully appreciated, special acknowledgment must be made to the New Haven Manufacturing Company for permitting daily visits of the classes to their shops for the study of machines and processes. The opportunity these visits afford the students of obtaining a knowledge of good machine shop practice is something, the value of which can not be too highly estimated, and the obligation to those granting it can not be too cordially expressed.

After the death of Mrs. Sheffield the Trustees of the school purchased the life-interest of Mr. George St. John Sheffield in the Sheffield homestead. This now goes under the name of

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The Biological Laboratory.

Previous to this time the Governing Board of the School had entered into an agreement with the Academical Department to provide instruction in Biology for a limited number of students from the Junior and Senior classes. The facilities of the then existing biological laboratories were, however, wholly inadequate to meet the growing demand for instruction in this department of the School and it was a difficult problem to decide how best to provide the necessary room for the proper expansion of this line of study. The acquisition of the Sheffield mansion offered a ready solution of the problem, and the Governing Board soon decided to convert the newly acquired building into a biological laboratory, in which all of the special studies of the biological course could be grouped together, viz : physiological chemistry, physiology, comparative anatomy, botany and general biology.

The work of reconstruction was commenced in June and on the opening of the term, in September, 1889, the building was ready for occupancy and thoroughly equipped with the apparatus and material needful for this line of work.

Fortunately, the large and roomy mansion proved well adapted for the purpose in view. On the ground floor, especially, many of the rooms were sufficiently large and well lighted to meet the requirements for a laboratory without much change ; where this was not the case, the removal of a few partition walls made possible the union of adjacent apartments, thus giving commodious rooms well suited for laboratory purposes. A few additional windows were needed to give sufficient light for microscopical work, and several outside chimneys were built to furnish the necessary ventilation flues for the chemical laboratories. Aside from these minor changes, the external appearance of the building remains substantially the same as before its occupancy as a laboratory. In order to provide for the suitable removal of all waste matter from the laboratories, a good sized sewer of several hundred feet in length, with suitable man holes, was built upon the newly acquired land and connected with the city's sewer on Grove street. In this way the needs of the present building were well provided for, while at the same time provision was made for the future, inasmuch as any new buildings erected upon this plot can be drained through the same channel.

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General Plan of the Interior.

The arrangements of rooms in the reconstructed building is as follows: The first floor is given up wholly to physiological chemistry and physiology. The parlor and a portion of the main hall, occupying the front of the main part of the house, have been united by the removal of the partition wall, and the large room which resulted has been converted into a lecture room for physiology and physiological chemistry. This room has a capacity for seating fifty persons and is provided with a long lecture table, fitted up with a pneumatic trough, sink, suction pump and other facilities for experimental lectures on these topics. There is likewise a large case on one side of the room for models and other appliances useful in the teaching of physiology. Connecting with this room, and with the adjacent laboratories, is a small room, formerly the parlor boudoir, which has been changed into a preparation room in which the experiments illustrative of the lectures can be arranged. The room can also be advantageously used as a private laboratory.

Directly back of the lecture room, in the central portion of the building, are two large rooms connecting with each other by a large hallway, formerly occupied as sitting room and dining room. These two rooms have been changed into research laboratories, where the more advanced work in physiological chemistry can be carried on. Large and commodious hoods were constructed, cases for apparatus, convenient working tables well supplied with gas and water, and other appliances necessary in laboratories of this order. The large butler's pantry adjacent to the dining room has been changed into a reagent closet, and one or two other small rooms have been utilized as storage closets for apparatus.

On each side of the main house is a large wing. The one to the north, comprising the former library and music room, has been made into a laboratory of physiological chemistry, for the use of students from the Academical Department taking the optional course in Biology. The two rooms have made a well lighted and commodious laboratory with accommodations for twenty persons, in addition to the hoods and other structures needed for general use. In the other wing, the one to the south, there were two main rooms, the picture gallery and a small parlor; these, together with a small hallway, were united by the

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removal of the partition walls and one large room obtained, which has been fitted up as a laboratory of physiological chemistry for the use of the students of the Scientific School taking the biological course. This room has accommodations for twenty persons in addition to tables and hoods for general use. Connected with this room is a smaller room used as a library and balance room. There is likewise a second small room provided with a large stone sink, designed especially for dialysis and other like purposes.

There are thus in the several laboratories of physiological chemistry accommodations for fifty to sixty persons, each working space being at least five feet long. Each desk or table is provided with four drawers and two lockers for apparatus, etc., large roomy sinks, pumps for rapid filtration and shelves for reagent bottles. All of the table tops are of heavy quartered oak, while the standing work is of clear pine, finished in the natural wood. The sinks are of iron, trapped and ventilated, while all drainage pipes in the building are of extra weight iron and exposed to view or laid in troughs which can be readily uncovered. The hoods are all floored with slabs of soapstone, to resist the action of chemicals and to diminish the danger of fire. In the several hoods are banks of constant level water-baths by which continuous evaporations can be carried on. Microscopes, balances for coarse and fine weighing, water-blast-lamps and other facilities for convenient and rapid work have been introduced. As a result, the laboratories of physiological chemistry are now the best equipped of any in the School, while the large, airy and well-lighted rooms make comfortable and agreeable places for work.

The second floor of the building is occupied as follows: The front room of the main building has been converted into a lecture room for comparative anatomy and botany, while the two small rooms adjoining it are used as private rooms for the professors of these two departments. The large room in the north wing has been made into a botanical laboratory, where instruction is given to students from both Departments—the Academical and Scientific. The three large rooms on the west side of the building have been converted into laboratories for instruction in general biology, comparative anatomy, and histology. These rooms are used in common by the Scientific and Academical classes in Biology, but

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in alternate terms. The central room is fitted up with cases for specimens and apparatus, microtomes, etc., and is reserved mainly for apparatus, general demonstrations and the use of the instructors. The other two apartments are fitted up with table room for thirty students, each place being provided with ample drawers, lockers and shelving for microscopes, etc.

Twenty new microscopes and other apparatus sufficient for the increased number of students have been added to the outfit. The third floor which contains several available rooms is not at present occupied, but is reserved for possible future growth and expansion.

The basement contains the coal and furnace rooms, storage rooms for apparatus, a room for the preparation of solutions and general chemical work, and a large frog tank supplied with running water.

The building, which has been named the Sheffield Biological Laboratory, can easily accommodate, with its present outfit, one hundred students and, as already stated, an effort has been made to introduce all the necessary appliances for thorough instruction and investigation in the branches of Biology represented in the Biological course.

Military Instruction.

At the request of the Governing Board for an officer of the United States Army to furnish fuller instruction in Military science, Charles A. L. Totten, first lieutenant in the 4th United States Artillery, was detailed for service at this institution by order No. 152, from the War Department, Adjutant-General's office, issued in July, 1889. Lieutenant Totten arrived here in the following month, and began his instruction the same Academic year. The particular method followed will be found in the account given of the courses of instruction in the appended catalogue. The result of this detail has been to give scope to this special branch, and to arouse increased interest in those students who are inclined to pay attention to military science.

The labors of Lieutenant Totten have been in other ways advantageous to the State. He has, with the consent of the Governing Board, held himself so far as he was able, at the service of volunteer organizations who were in need of his advice or

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assistance. In particular, during a part of the last year, he was nominally in charge of the Battalion of the Bridgeport High School, and weekly during the spring drilled the Governor's Foot Guards at Hartford.

Addition to the Fund for the Land-Grant Colleges.

The present Congress has passed the following act, which is of so much importance to the interests of this school, that it is desirable to give it in full.

AN ACT to apply a portion of the proceeds of the public lands to the more complete endowment and support of the Colleges for the benefit of Agricultural and the Mechanic Arts established under the provisions of an Act of Congress approved July second, eighteen hundred and sixty-two.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That there shall be, and hereby is, annually appropriated, out of any money in the Treasury not otherwise appropriated, arising from the sales of public lands, to be paid as hereinafter provided, to each State and Territory for the more complete endowment and maintenance of colleges for the benefit of agriculture and the mechanic arts now established, or which may be hereafter established, in accordance with an act of Congress approved July second, eighteen hundred and sixty-two, the sum of fifteen thousand dollars for the year ending June thirtieth, eighteen hundred and ninety, and an annual increase of the amount of such appropriation thereafter for ten years by an additional sum of one thousand dollars over the preceding year, and the annual amount to be paid thereafter to each State and Territory shall be twenty-five thousand dollars to be applied only to instruction in agriculture, the mechanic arts, the English language and the various branches of mathematical, physical, natural and economic science, with special reference to their applications in the industries of life, and to the facilities for such instruction: *Provided*, That no money shall be paid out under this act to any State or Territory for the support and maintenance of a college where a distinction of race or color is made in the admission of students, but the establishment and maintenance of such colleges separately for white and colored students shall be held to be a compliance with the provisions of this act if the funds received in such State or Territory be equitably divided as hereinafter set forth: *Provided*, That in any State in which there has been one college established in pursuance of the act of July second, eighteen hundred and sixty-two, and also in which an educational institution of like character has been established, or may be hereafter established, and is now aided by such State from its own revenue, for the education of colored students in agriculture and the mechanic arts, however named or styled, or

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whether or not it has received money heretofore under the act to which this act is an amendment, the Legislature of such State may propose and report to the Secretary of the Interior a just and equitable division of the fund to be received under this act between one college for white students and one institution for colored students established as aforesaid, which shall be divided into two parts and paid accordingly, and thereupon such institution for colored students shall be entitled to the benefits of this act and subject to its provisions, as much as it would have been if it had been included under the act of eighteen hundred and sixty-two, and the fulfillment of the foregoing provisions shall be taken as a compliance with the provision in reference to separate colleges for white and colored students.

SEC. 2. That the sums hereby appropriated to the States and Territories for the further endowment and support of colleges shall be annually paid on or before the thirty-first day of July of each year, by the Secretary of the Treasury, upon the warrant of the Secretary of the Interior, out of the Treasury of the United States, to the State or Territorial Treasurer, or to such officer as shall be designated by the laws of such State or Territory to receive the same, who shall, upon the order of the trustees of the college, or the institution for colored students, immediately pay over said sums to the treasurers of the respective colleges or other institutions entitled to receive the same, and such treasurers shall be required to report to the Secretary of Agriculture and to the Secretary of the Interior, on or before the first day of September of each year, a detailed statement of the amount so received and of its disbursement. The grants of moneys authorized by this act are made subject to the legislative assent of the several States and Territories to the purpose of said grants: *Provided*, That payments of such installments of the appropriation herein made as shall become due to any State before the adjournment of the regular session of legislature meeting next after the passage of this act shall be made upon the assent of the governor thereof, duly certified to the Secretary of the Treasury.

SEC. 3. That if any portion of the moneys received by the designated officer of the State or Territory for the further and more complete endowment, support and maintenance of colleges, or of institutions for colored students, as provided in this act, shall, by any action or contingency, be diminished or lost, or be misapplied, it shall be replaced by the State or Territory to which it belongs, and until so replaced no subsequent appropriation shall be apportioned or paid to such State or Territory; and no portion of said moneys shall be applied. directly or indirectly, under any pretense whatever, to the purchase, erection, preservation, or repair of any building or buildings. An annual report by the president of each of said colleges shall be made to the Secretary of Agriculture, as well as to the Secretary of the Interior, regarding the condition and progress of each college, including statistical information in relation to its receipts and expenditures, its library, the number of its students and professors, and also as to any improvements and experiments made under the direction of any experiment stations

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attached to said colleges, with their costs and results, and such other industrial and economical statistics as may be regarded as useful, one copy of which shall be transmitted by mail free to all other colleges further endowed under this act.

SEC. 4. That on or before the first day of July in each year, after the passage of this act, the Secretary of the Interior shall ascertain and certify to the Secretary of the Treasury as to each State and Territory whether it is entitled to receive its share of the annual appropriation for colleges, or of institutions for colored students, under this act, and the amount which thereupon each is entitled, respectively to receive. If the Secretary of the Interior shall withhold a certificate from any State or Territory of its appropriation the facts and reasons therefor shall be reported to the President, and the amount involved shall be kept separate in the Treasury until the close of the next Congress, in order that the State or Territory may, if it should so desire, appeal to Congress from the determination of the Secretary of the Interior. If the next Congress shall not direct such sum to be paid it shall be covered into the Treasury. And the Secretary of the Interior is hereby charged with the proper administration of this law.

SEC. 5. That the Secretary of the Interior shall annually report to Congress the disbursements which have been made in all the States and Territories, and also whether the appropriation of any State or Territory has been withheld, and if so, the reasons therefor.

SEC. 6. Congress may at any time amend, suspend, or repeal any or all of the provisions of this act.

Approved, August 30, 1890.

DEATH OF PROFESSOR LYMAN.

For the second time in the history of the School the Governing Board are under the painful necessity of chronicling the loss of one of their number by death. On the 29th of January, 1890, died at his home in New Haven, Professor Chester S. Lyman, who for more than thirty years had been connected with this institution. Since 1886 increasing infirmities had rendered it impossible for him to perform any active service; but up to that time he had discharged without any intermission the duties of his various positions.

Professor Lyman was born in Manchester, Conn., on January 13, 1814. He was early interested in scientific studies, his attention having been specially turned to astronomy. Having, however, concluded to take up the profession of the ministry he entered Yale College with that intention, and was graduated in 1837. During his course he was specially marked by his literary tastes, and was one of the founders of the Yale Literary Magazine, the oldest college periodical now existing in the country.

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After graduation he taught for two years and then began the study of theology at the Union Theological Seminary in New York. Subsequently he went to the Yale Divinity School, and from that he graduated in 1842. In that year he was called to the pastorate of the first Congregational Church in New Britain. There, however, he did not long remain. His health speedily gave way, and in April, 1845, he gave up his pastorate, and soon set out for another climate in the hope of regaining his health.

In October he sailed for the Hawaiian Islands, where he remained for over a year. There his tastes prompted him to pay special attention to subjects connected with science, and he made a series of observations upon the volcano of Kilauea which attracted much attention by their announcement of certain hitherto unrecognized principles of volcanic action. While in the Sandwich Islands he was engaged for several months, also in teaching at the Royal School. Among his pupils were four young chiefs who successively ascended the throne. In the Hawaiian Islands he remained till June, 1847, when he set sail for California, which had recently come into the possession of the United States.

In California he remained between two and three years, engaged principally in surveying. He was there when the first discoveries of gold were made, and his account published in the American Journal of Science was among the first, if not the very first that reached the East, which was regarded as establishing the fact of the discovery beyond question.

In 1850 he returned to New Haven and then settled in his permanent home. He devoted himself largely to scientific study, and in 1859 was appointed Professor of Industrial Mechanics and Physics at the Scientific School, then in its infancy still. To the growth and prosperity of this institution he devoted himself with unflinching fidelity for the rest of his life. With the increase of numbers it was found necessary to relieve him of a portion of his duties, and in 1872 the title of his chair was changed to Astronomy and Physics. The duties of these two departments he continued to discharge until 1884. In that year in consequence of his impaired health he gave up the professorship of Physics, a new chair having been created for that department. He continued, however, to give instruction in Astronomy until 1886, when he was obliged to abandon teaching entirely. In 1889 he was made Emeritus Professor, and in the following year he died, having lived a few days beyond his seventy-sixth birthday.

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Professor Lyman was an almost marvellously expert mechanician and invented several pieces of apparatus now widely used by teachers in science. In addition to his scientific attainments he was of a remarkably sweet and gentle nature, and it has been rarely the case that anyone has been so generally beloved both by those who were under his instruction and those who were brought into contact with him in any other capacity.

Public Lectures.

During the past two years the regular annual courses of lectures to mechanics and others have been given in the lecture room in North Sheffield Hall. The names of the lecturers and the subjects of the lectures were as follows:

Twenty-Third Annual Course, 1889.

I.	Friday,	Feb. 22.—The Great Basin.	Prof. Brewer.
II.	Tuesday,	" 26.—Oaks.	Prof. Daniel C. Eaton.
III.	Friday,	Mar. 1.—Petroleum and Natural Gas.	Prof. J. S. Newberry.
IV.	Tuesday,	" 5.—Chemical Analysis.	Prof. Wells.
V.	Friday,	" 8.—Prison Reform.	Prof. F. Wayland.
VI.	Tuesday,	" 12.—Science and Immortality.	Prof. DuBois.
VII.	Friday,	" 15.—Fast Trains.	Prof. Hadley.
VIII.	Tuesday,	" 19.—New England Town Government.	Mr. Henry C. White.
IX.	Friday,	" 22.—The Laborer and his Employer.	President F. A. Walker.
X.	Tuesday,	" 26.—The Scientific Study of Infant Intelligence.	Mr. Henry T. Blake.
XI.	Friday,	" 29.—The Worship of Meteorites.	Prof. Newton.
XII.	Tuesday,	Apr. 2.—The Antiquity of Man.	Prof. A. E. Verrill.

Twenty-Fourth Annual Course, 1890.

I.	Friday,	Feb. 14.—About Fiction and Other Things.	Mr. Charles Dudley Warner.
II.	Tuesday,	" 18.—The Acquisition of Oregon.	Prof. Brewer.
III.	Friday,	" 21.—The Mystery of Egypt.	Prof. C. A. L. Totten.
IV.	Tuesday,	" 25.—Water Lilies.	Prof. Daniel C. Eaton.
V.	Friday,	" 28.—The London Earthquake of 1750.	Prof. Lounsbury.
VI.	Tuesday,	Mar. 4.—Pools and Trusts.	Prof. Hadley.
VII.	Friday,	" 7.—Recent Researches on the Brain.	Prof. H. H. Donaldson.
VIII.	Tuesday	" 11.—History of the Discovery and Decipherment of the Cuneiform Inscriptions.	Dr. Robert F. Harper.
IX.	Friday,	" 14.—House Sanitation,	Mr. Albert L. Webster.
X.	Tuesday,	" 18.—The Evolution of the French Château.	Prof. D. Cady Eaton.
XI.	Friday,	" 21.—The Amateur Photographer.	Prof. Farnam.
XII.	Tuesday,	" 25.—The French Exhibition of 1889.	Prof. Hastings.

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States Represented in the School.

The following table shows the States and Countries from which come the students whose names have appeared on the catalogue during the two years past, and the proportion of numbers that belong to each. The first table gives the numbers for the Academic year, 1889–90.

	Graduates.	Seniors.	Juniors.	Freshmen.	Special.	Total.
California	--	1	3	3	--	7
Colorado	--	--	1	4	--	5
Connecticut	9	32	36	39	4	120
Delaware	--	1	--	1	--	2
Georgia	--	--	--	2	--	2
Illinois	1	4	9	11	2	27
Indiana	--	--	4	3	--	7
Kansas	--	--	1	--	--	1
Kentucky	--	2	1	--	--	3
Louisiana	1	--	--	--	--	1
Maine	1	--	2	--	--	3
Maryland	--	--	1	1	--	2
Massachusetts	1	--	2	6	--	9
Michigan	1	--	1	1	--	3
Minnesota	--	--	1	3	--	4
Missouri	--	2	1	1	--	4
Nebraska	--	--	4	1	--	5
New Jersey	1	1	1	5	--	8
New York	3	13	24	28	1	69
Ohio	1	5	9	2	--	17
Pennsylvania	3	2	4	15	--	24
Rhode Island	--	3	2	--	--	5
Tennessee	--	--	1	--	--	1
Vermont	--	--	--	2	--	2
Washington	--	1	--	--	--	1
Wisconsin	--	1	1	--	--	2
District of Columbia	--	--	1	--	--	1
New Mexico	--	--	--	1	--	1
Canada	--	1	--	1	--	2
England	--	--	--	1	--	1
Japan	--	--	1	--	--	1
Sandwich Islands	1	--	-	1	--	2
Turkey	1	--	--	--	--	1
Total	24	69	111	132	7	343

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The following is the table for the present Academic year, 1890–91.

	Graduates.	Seniors.	Juniors.	Freshmen.	Special.	Total.
Alabama	--	--	--	1	--	1
California	1	3	2	5	--	11
Colorado	--	1	4	1	--	6
Connecticut	13	28	32	42	1	118
Delaware	--	--	1	3	--	4
Georgia	--	--	2	2	--	4
Illinois	1	4	13	10	2	30
Indiana	--	3	2	2	--	7
Kansas	--	1	--	--	--	1
Kentucky	--	--	--	1	--	1
Louisiana	1	--	--	1	--	2
Maine	1	2	--	--	--	3
Maryland	--	1	--	1	--	2
Massachssetts	2	2	5	3	--	12
Michigan	--	--	1	5	--	6
Minnesota	--	1	1	5	--	7
Missouri	--	1	1	7	--	9
Nebraska	--	4	1	1	--	6
New Jersey	1	1	3	2	--	7
New York	2	22	29	21	1	75
Ohio	1	8	1	10	1	21
Oregon	--	--	--	1	--	1
Pennsylvania	1	3	13	9	--	26
Rhode Island	1	1	--	--	--	2
Tennessee	--	1	1	--	--	2
Vermont	--	--	2	--	--	2
West Virginia	1	--	--	--	--	1
Wisconsin	--	1	--	--	1	2
Arizona	--	--	--	1	--	1
District of Columbia	--	1	--	1	--	2
New Mexico	--	--	1	--	--	2
Canada	--	--	1	1	--	2
England	--	--	1	--	--	1
Japan	--	1	--	--	--	1
Sandwich Islands	1	--	1	--	--	2
Turkey	1	--	--	--	--	1
Total	30	90	118	136	5	381

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Anniversaries.

In the following schedules are given the names of the candidates for degrees in the years 1889 and 1890. The subjects of the graduation theses are also published. The names in the first lists of the Bachelors of Philosophy in each year are of those who stood highest in their respective courses. Those marked with an asterisk read theses in the evening.

The exercises of the Graduating Class of 1889 were held in North Sheffield Hall on the evening of Tuesday, June 24. The names of the candidates are here given, as well as the list of prizes announced at that Anniversary.

Bachelors of Philosophy (70).

Arthur Chambers Alexander (Mechanical Engineering), *Honolulu, H. I.* On Tangent Galvanometers.

James Bradshaw Bailey (Mechanical Engineering), *Harrisburgh, Pa.* On Crank Motion.

*Frank Arthur Busse (Mechanical Engineering), *New Haven.* On Liquid Fuel.

Perry Moore Caldwell (Chemistry), *Wheeling, W. Va.* On the Isomorphism of Zinc and Irod in Sphalerite.

*Frederick Howard Ellsworth (Civil Engineering), *Hartford, Conn.* On the Construction of Permanent Way.

Harootum Enfiajian (Select), *Harpoot, Turkey.* On the Theories of the Source of Solar Heat.

Henry Pierce Hall (Mechanical Engineering), *San Francisco, Cal.* On the Zalinski Pneumatic Dynamite Torpedo Gun.

John Augustus Hartwell (Biology), *Unionville, N. Y.* On the Relative Formation of Albumoses and Peptone in Gastric Digestion.

*Leland Howard (Mechanical Engineering), *Hartford, Conn.* On Coal Breakers.

David Lyman (Mechanical Engineering), *Middlefield.* On the Manufacture of Paper.

*Kingsley Walton Martin (Biology), *Staten Island, N. Y.* On the Achroodextrin of Salivary Digestion.

William Brewster Morrison (Mechanical Engineering), *Willimantic.* On the Theory of Trajectories.

*William Belknap Newberry (Chemistry), *New Haven.* On Sandmeyer's Method.

Frank Lee Owen (Mechanical Engineering), *Oakland, Cal.* On Coast Defense by Submarine Attack.

Kenyon Vickers Painter (Civil Engineering), *Cleveland, O.* On the Water Supply of Cleveland, O.

*Irwin Rew (Select), *Chicago, Ill.* On the History and Development of Gas Works.

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CHARLES EMERSON STONE (Select), *Spencer, Mass.* On the Art of Lithography.

*HARRY MIGHELS VERRILL (Select), *Portland, Me.* On the Jesuits in North America.

GUTHRIE MINOR WILSON (Select), *Bardstown, Ky.* On the Sugar Bounties Convention.

WILLIAM BELKNAP ALLEN (Civil Engineering), *Pewee Valley, Ky.* On the Hoosac Tunnel, with the Methods of Excavation used in its Construction.

LOUIS LAWRENCE BARNUM, LL.B. (Select), *Thompsonville.* On the Industrial Remuneration Conference of 1885.

WILLIAM BARTLETT BECKLEY (Mechanical Engineering), *New Haven.* On Hydraulic Dredging.

WILLIAM DENNISON BREED (Mechanical Engineering), *Cincinnati, O.* On Ice Machines.

WILLIAM FRANCIS BREEZE (Mechanical Engineering), *San Francisco, Cal.* On the Manufacture of Steel.

GEORGE TYLER BURROUGHS, JR. (Mechanical Engineering), *Chicago, Ill.* On a Comparison of English and American Locomotives.

HENRY STUDLEY BURROUGHS (Civil Engineering), *Chicago, Ill.* On the Comparison and Designing of Iron Plate Railway Girders.

ARTHUR SANFORD CHENEY (Biology), *New Haven.* On the Structure and Function of the Kidney.

WILLIAM SHINN CLAWSON (Select), *Woodstown, N. J.* On Coal-Tar and its Products.

WILLIAM HILLARD CONYNGHAM (Select), *Wilkesbarre, Pa.* On the Preparation of Anthracite Coal for Market.

FRANK MARCUS COOPER (Civil Engineering), *Kingston, Pa.* On the Design and Construction of High Masonry Dams.

LOUIS JULIUS CURTIS (Select), *Stamford.* On the Distribution of the Surplus.

ARTHUR HERBERT DAY (Chemistry), *New Haven.* On the Separation of Columbic and Tantalic Acids.

EDWARD HANGARY DAY (Select), *New Albany, Ind.* On Penny Postage.

EDWIN KIRK DILLINGHAM (Civil Engineering), *New Orleans, La.* On Railroad Track, its Maintenance and Repair.

LOUIS COERT DUBOIS (Civil Engineering), *Hudson, N. Y.* On the Construction of the Jetties at the Mouth of the Mississippi.

EDWARD EVEREST (Select), *Newark, N. J.* On Flour Milling.

WILLIAM IRVING FERREY (Mechanical Engineering), *Pittsfield, Mass.* On the Maxim Automatic Machine Gun.

THERON ROCKWELL FIELD (Civil Engineering), *New York City.* On the Economic Relations of Grade and Curvature in Railroad Location.

GEORGE FRANK GOODALE (Civil Engineering), *New Haven.* On the Suez Canal.

LEWIS BROWN GAWTRY (Chemistry), *New York City.* On Dibenzylketon.

LEWIS MONTROSE HAIGHT (Chemistry), *Alameda, Cal.* On Para-amidodiphenylamine.

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ALFRED HAND, JR., A.B. (Biology), *Scranton, Pa.* On Elastoses and Elastin Peptone.

ARTHUR GRANT HUNTINGTON (Civil Engineering), *Cleveland, O.* On Tunnel Construction.

ARTHUR WISWELL JEPSON (Mechanical Engineering), *New Haven.* On the Hydraulic Transmission of Power.

JOHN HENRY KLOCK, JR. (Chemistry), *New Haven.* On the Precipitation of Copper with Sodium Thiosulphate.

GEORGE ALFRED LUND (Civil Engineering), *West Stratford.* On the Theory and Practice of Railroad Location.

BOYNTON WELLS MCFARLAND (Civil Engineering), *New Haven.* On the Proposed Nicaragua Canal, with Estimate of Cost.

FERRIS JACOBS MEIGS (Select), *New York City.* On the Timber Supply of the United States with Special Reference to the Lumber Interest.

GEORGE WELLINGTON MILES, JR. (Chemistry), *Milford.* On Chrysoidine

JOHN RAYMOND MITCHELL (Civil Engineering), *Franklin, Pa.* On the Stability of Retaining Walls, with Comparison of Different Methods of Calculation.

AUGUSTUS RENÉ MOËN (Select), *New York City.* On the Orange Societies of Ireland.

EDWIN MORRISON (Mechanical Engineering), *Cincinnati, O.* On an Electric Plant for Yale University.

ROGER SAMUEL NEWELL (Civil Engineering), *Bristol.* On the Determination of the Economic Dimensione of Iron Railroad Bridges.

WILLIAM HENRY PIERCE (Mechanical Engineering), *South Britain.* On the Theory and Construction of Turbines.

EDWIN REED (Select), *Brooklyn, N. Y.* On the Exhaustion of Coal.

HENRY WORK RIANHARD (Select), *New York City.* On the Fast Mail Train Service.

PAUL SKIFF ROBINSON (Biology), *New Haven.* On the Micro-Organic Life of Water and Ice in its Relation to Disease.

PAUL SHEAFER (Mechanical Engineering), *Pottsville, Pa.* On Pneumatic Tubes.

ARTHUR BERTRAM SKELDING (Mechanical Engineering), *Riverside.* On Electric Street Railways.

FRED PALMER SOLLY, A.B. (Biology), *Orange, N. J.* On the Products formed by the Gastric and Pancreatic Digestion of Gelatin.

LEWIS HOBART SWEETZER (Mechanical Engineering), *San Francisco, Cal.* On the Cable Railway Systems of San Francisco.

HENRY HUTCHINS SYKES (Mechanical Engineering), *New Haven.* On Electric Conduits and Subways.

OREN EDWARD TAFT (Mechanical Engineering), *Chicago, Ill.* On the Naphtha-Gas Motor.

ABRAHAM LOUIS THALHEIMER (Mechanical Engineering), *New Haven.* On Hot Air Engines.

CHARLES NEWMAN TRAVER (Mechanical Engineering), *Hudson, N. Y.* On the Water Supply of Hudson, N. Y.

CLARENCE BEECHER TWICHELL (Mechanical Engineering), *New Haven.* On Compressed Air Motors for Street Cars.

BROWNLEE ROBERTSON WARD, A.B. (Biology), *New Haven.* On Myosin Peptone.

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ROBERT TAYLOR WHEELER (Biology), *Jersey City, N. J.* On the Influence of Baking Powder Residues on Gastric Digestion.

JULIAN VALLETTE WRIGHT (Mechanical Engineering), *Cincinnati, O.* On Hydraulic Mining.

WILLIAM CHARLES WURTENBERG (Biology), *Willink, N. Y.* On the Influence of the Floating Matter of the Air upon Putrefaction and Infection.

PRIZES.

CLASS OF 1889.

The Belknap Natural History Prize—CHARLES E. STONE, with honorable mention of JOHN A. HARTWELL, WILLIAM B. NEWBERRY, and GUTHRIE M. WILSON.

For excellence in Civil Engineering—FREDERICK H. ELLSWORTH.

For excellence in Mechanical Engineering, the prize divided between FRANK A. BUSSE and WILLIAM B. MORRISON.

CLASS OF 1890.

For excellence in all the Mathematics of the Junior Year—FRANK R. RICH.

For excellence in German—FRANK R. RICH, with honorable mention of ALEXANDER W. EVANS, both having shown exceptional excellence.

CLASS OF 1891.

For excellence in all the Studies of Freshman Year, the prize divided between NOYES D. CLARK and GEORGE P. STARKWEATHER, with honorable mention of DE LANCY A. CAMERON, THEODORE C. JANEWAY, and EDWARD O. SUTTON.

For excellence in Chemistry, the prize divided between BURTON D. BLAIR, ARTHUR E. BOOTH, DE LANCY A. CAMERON, THEODORE C. JANEWAY, and GEORGE P. STARKWEATHER.

For excellence in Physics, the prize divided between NOYES D. CLARK and THEODORE C. JANEWAY, with honorable mention of DAVID L. HUNTINGTON and GEORGE P. STARKWEATHER.

For excellence in Mathematics, the prize divided between DE LANCY A. CAMERON, NOYES D. CLARK, and GEORGE P. STARKWEATHER, with honorable mention of CLIFFORD W. LEAVENWORTH.

For excellence in German—EDWARD O. SUTTON.

For excellence in Mechanical Drawing—CHARLES H. SAUNDERS.

The Exercises of the Graduating Class of 1890 were held in North Sheffield Hall in the evening of Monday, June 23d. The following is the list of the candidates for degrees, and of the prizes that were announced on that occasion.

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Civil Engineers (2).

Frank Elwood Brown, Ph.B., *Redlands, San Bernardino Co., Cal.* Original Design for the Bear Valley Arched Dam.

Morgan Walcott, Ph.B., *New York City.* The Designing of Iron and Steel Railway Bridges.

Mechanical Engineer (1).

James Alward Seymour, Ph.B., *Auburn, N. Y.* A Design for a Compound High Speed Steam Engine.

Bachelors of Philosophy (64).

William Lucius Armstrong, B.A. (Biology), *Chicago, Ill.* On the Digestion of Living Tissue.

George Perkins Bissell, Jr. (Mechanical Engineering), *Wilmington, Del.* On Turreted War Ships.

*Theodore Whitney Blake (Mechanical Engineering), *Whitneyville.* On an Investigation of the Electrical Properties of Certain Alloys.

Wendell Phillips Brown (Civil Engineering), *Plainfield.* On Bridge and Pier Foundations.

John Platt Cheney (Chemistry), *South Manchester, Conn.* On the Separation of Arsenic, Tin and Antimony.

*Ralph Roger Clapp (Chemistry), *Pawtucket, R. I.* On the Structure of the Sodium and Silver Salts of Form-ortho-toluide.

Harry Goodyear Day (Select), *Seymour.* On the Nicaragua Canal.

*Walter Dodge (Biology), *Stamford.* On the Histology of the Mucous Membrane of the Stomach of the Cat.

*Harrison Irwin Drummond (Select), *St. Louis, Mo.* On Tobacco as a Commercial Product of the United States.

Julian DuBois (Mechanical Engineering), *Hudson, N. Y.* On Steam Fire Engines.

*Alexander William Evans (Biology), *New Haven.* On the Classification of the Hepaticæ.

Ralph Schuyler Goodwin, Jr. (Biology), *Thomaston.* On Myosine Peptone.

Neil Gray, Jr. (Mechanical Engineering), *Oswego, N. Y.* On Link Motions.

*Everett Gallup Griggs (Select), *Tacoma, Wash.* On the Lumber Production and Lumber Supply of the Pacific Slope.

*Charles Newton Gunn (Civil Engineering), *New Haven.* On Rapid Transit in New York City.

Charles Louis Kirschner (Mechanical Engineering), *New Haven.* On Torpedo Boats.

*Harvey Merrill Lawson (Agriculture), *Union.* On the History of the Turnip, and its Place in British Agriculture.

Franklin Lyman Lawton (Biology), *Meriden.* On the Glycogenic Function of the Liver.

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OLIVER SMITH LYFORD, JR. (Mechanical Engineering), *Chicago, Ill.* On the Dynamo: a History.

JOHN CARTER MACHALE (Mechanical Engineering), *Sawyer City, Pa.* On Deep Well Boring.

*WILLIAM CROSBY MARSHALL (Mechanical Engineering), *Cromwell.* On High Speed Steam Engines.

ALFRED WALLING OGDEN (Chemistry), *Keyport, N. J.* On the Basic Salts of Zinc.

ROBERT ELLSWORTH PECK (Biology), *New Haven.* On the Histology of the Small Intestine of the Cat.

JOHN FREDERICK PENNELL (Civil Engineering), *New Haven.* On the Separate and Combined Systems of Sewerage.

*FRANK RUSSELL RICH (Civil Engineering), *New Haven.* On Grade and Curvature and their Effect on Railway Traffic.

CHARLES TALBOT RICHMOND (Mechanical Engineering), *Providence, R. I.* On the Grinell Automatic Sprinkler.

ERNEST ELISHA SEVERY (Select), *Waterbury.* On the Italian Sonnet in English.

CHESTER BURDELL SHEPARD (Civil Engineering), *Middletown.* On Topographical Surveying.

ALBERT MILFORD TURNER (Civil Engineering), *Northfield.* On Uniform Live Loads with Locomotive Excess, versus Concentrated Wheel Loads in the Designing of Railway Bridges.

*HENRY LORD WHEELER (Chemistry), *Chicago, Ill.* On the Structure of the Sodium and Silver Salts of Formyl-*a*-naphthylamine.

PHILIP ALLEN (Civil Engineering), *Providence, R. I.* On Different Methods of Calculating Bridge Strains.

CYRUS MORGAN ARNOLD (Civil Engineering), *New York City.* On the Forth Bridge.

HORACE RAY BURRITT (Mechanical Engineering), *New Haven.* On Refrigerating and Ice-making Machinery.

WILLIAM HARPER BUTLER (Mechanical Engineering), *Olean, N. Y.* On Multiple Expansion Steam Engines.

ROBERT LOCKWOOD CASEMENT (Chemistry), *Painesville, O.* On the Separation of Selenium and Tellurium.

HORACE BUSHNELL CHENEY (Mechanical Engineering), *South Manchester.* On Textile Printing.

CLARENCE BEVERLY DAVISON (Civil Engineering), *New York City.* On the Best Process of Making Illuminating Gas.

NELSON LLOYD DEMING (Chemistry), *Danbury.* On the Preparation of the Amidines.

LAWRENCE HEYWORTH (Select), *Chicago, Ill.* On the Cable Car Systems of the United States.

THEODORE DUDLEY IRWIN (Select), *Albany, N. Y.* On the Sea Coast Defence of the United States.

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ADRIAN MULLER ISHAM (Civil Engineering), *New York City.* On Railroad Switches.

WALTER TRACY IVES (Mechanical Engineering), *Montreal, Canada.* On the Manufacture of Steel.

WILLIAM FRANCIS JUDSON (Select), *New York City.* On the Competition of the Russian and Indian Wheat Fields with those of the United States.

ELBRIDGE BYRON KEITH (Select), *Chicago, Ill.* On Recent Proposals regarding the Circulation of the National Banks.

WILLIAM MATTHEW KENNA (Biology), *New Haven.* On Bacteria and their Effects.

EUGENE LENTILHON (Civil Engineering), *New York City.* On some Proposed Improvements at the New York Navy Yard.

HERBERT MCBRIDE (Select), *Cleveland, O.* On the Congo Free State and its Commercial Prospects.

FRANK DUNLEVY MCCAULLEY (Select), *New York City.* On the History of Silver since 1878.

HENRY PORTER MCKNIGHT (Civil Engineering), *Louisville, Ky.* On the New Croton Aqueduct of New York City.

FRANK ALOYSIUS MALONEY (Civil Engineering), *New Haven.* On Artificial Water Storage.

FREDERICK JAMES MANN (Biology), *Utica, N Y.* On Fermentation and Putrefaction.

JAMES MOORHEAD MURDOCH (Biology), *Pittsburgh, Pa.* On the Antiseptic Method of Treating Wounds.

PAUL NASH (Civil Engineering), *Westport.* On the Designing of High Masonry Dams.

EDGAR BURR NORTHRUP (Civil Engineering), *Broadalbin, N. Y.* On Retaining Walls.

CHARLES AUGUSTUS OTIS, JR. (Chemistry), *Cleveland, O.* On the Determination of Manganese in the Presence of Calcium.

GAIUS FOSTER PADDOCK (Chemistry), *St. Louis, Mo.* On the Determination of Lead.

JOHN CONOVER POWELL (Civil Engineering), *Dayton, O.* On Steel Rails, their Best Form and Economic Importance.

WILLIAM STERLING ROBY (Select), *Rochester, N. Y.* On the Relations of the Government to the Telegraph Service.

CHARLES FRANCIS ROGERS (Mechanical Engineering), *New Canaan.* On the Corliss Valve Gear.

AMOS LEIVENSPERGER SCHAEFFER, B.A. (Civil Engineering), *Fleetwood, Pa.* On Railroad Accidents.

GEORGE JARVIS SPENCER (Mechanical Engineering), *Old Saybrook.* On an Electric Motor for Street Cars.

WALTER TUTTLE SPENCER (Civil Engineering), *Guilford.* On Foundations.

CHARLES BAILEY SPRUCE (Chemistry), *Kenosha, Wisc.* On the Separation of Manganese and Magnesium.

JOHN CLAYTON TRACY (Civil Engineering), *Fair Haven.* On Preliminary Surveys for Railway Location.

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Prizes.

CLASS OF 1890.

For excellence in Civil Engineering, the prize divided between Frank Russell Rich, *New Haven*, and Albert Milford Turner, *Northfield*, with honorable mention of Charles Newton Gunn, *New Haven*.

For excellence in Mechanical Engineering, the prize divided between Charles Louis Kirschner, *New Haven*, and William Crosby Marshall, *Cromwell*.

The Belknap Natural History Prize, awarded to Alexander William Evans, *New Haven*, with honorable mention of Walter Dodge, *Stamford*, and Harvey Merrill Lawson, *Union*.

CLASS OF 1891.

For excellence in Mathematics of Junior Year, the prize awarded to George Pratt Starkweather, *New Haven*, with honorable mention of DeLancey Allen Cameron, *Caledonia, N. Y.*, and Noyes Dwight Clark, *Woodbridge*.

For excellence in German, the prize awarded to George Pratt Starkweather, *New Haven*, with honorable mention of Edward Owen Sutton, *Springfield, Mass.*

CLASS OF 1892.

For excellence in all the Studies of Freshman Year, the prize awarded to Samuel Atkinson Harsh, *Denver, Col.*, with honorable mention of Francis Mullikin Adams, *New Haven*, Sherman Hoyt Bouton, *Chicago, Ill.*, and Claude Gignoux, *Monroe, N. Y.*

For excellence in German, the prize divided between Samuel Atkinson Harsh, *Denver, Col.*, and Claude Gignoux, *Monroe, N. Y.*, with honorable mention of Francis Mullikin Adams, *New Haven*, George Eli Nettleton, *New Haven*, and Paul Sterling, *Bridgeport*.

For excellence in Chemistry, the prize divided between Francis Mullikin Adams, *New Haven*, Claude Gignoux, *Monroe, N. Y.*, Samuel Atkinson Harsh, *Denver, Col.*, and George Eli Nettleton, *New Haven*.

For excellence in Physics, the prize awarded to Bartram Borden Boltwood, *Castleton, N. Y.*, with honorable mention of Samuel Atkinson Harsh, *Denver, Col.*, and Charles Butler Chandler, *Hartford*.

For excellence in Mathematics, the prize awarded to Samuel Atkinson Harsh, *Denver, Col.*, with honorable mention of Francis Mullikin Adams, *New Haven*, Sherman Hoyt Bouton, *Chicago, Ill.*, Claude Gignoux, *Monroe, N. Y.*, and Theophilus Nelson, *Bridgeport*.

For excellence in Mechanical Drawing, the prize awarded to Waldo Clayton Briggs, *New Haven*, with honorable mention of William Atwater Baldwin, *Lahaina, Maui, H. I.*, Samuel Fray, *Bridgeport*, Josiah Harmar, *Philadelphia, Pa.*, and Theophilus Nelson, *Bridgeport*.

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PROGRAMME OF STUDIES

AND

CATALOGUE,

FOR THE COLLEGE YEAR, 1890-91.

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CALENDAR.

1890.		
25 Sept.,	Thursday,	First Term begins.
17 Dec.,	Wednesday,	First Term ends.
1891.		**Winter Vacation.**
6 Jan.,	Tuesday,	Second Term begins.
25 March,	Wednesday,	Spring Recess begins.
1 April,	Wednesday,	Spring Recess ends.
22 June,	Monday,	Anniversary.
23 June,	Tuesday,	Meeting of Appointing Board.
24 June,	Wednesday,	Commencement.
25 June,	Thursday,	Examinations for Admission begin.
		Summer Vacation.
22 Sept.,	Tuesday,	Examinations for Admission begin.
24 Sept.,	Thursday,	First Term begins.
16 Dec.,	Wednesday,	First Term ends.

ABBREVIATIONS.

S. H.	Sheffield Hall.
N. S. H.	North Sheffield Hall.
B	Sheffield Biological Laboratory
TR.	Treasury Building.
D.	Durfee College.
F.	Farnam College.
E.	East Divinity Hall.
W.	West Divinity Hall.
P. M.	Peabody Museum.
A.	Absent on leave.

In the buildings belonging to the Sheffield Scientific School, the rooms numbered from 1 to 21 are in Sheffield Hall; from 25 to 58 in North Sheffield Hall; from 60 to 79 in the Sheffield Biological Laboratory.

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JANITOR OF SHEFFIELD BIOLOGICAL LABORATORY.

WILLIAM COULTER, Janitor's House.

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GRADUATE STUDENTS.

Arthur Chambers Alexander, PH.B. Yale University, 1889.	*Honolulu, H. I.*	57 N. S. H.
George L. Amerman, B.A. Yale University, 1890.	*New Haven, Conn.*	137 Wall st.
Frederic Elijah Beach, PH.B. Yale University, 1888.	*New Haven, Conn.*	44 Lyon st.
William Frances Breeze, PH.B. Yale University, 1889.	*San Francisco, Cal.*	New Haven House.
Philip Embury Browning, B.A. Yale University, 1889.	*Brooklyn, N. Y.*	106 High st.
William Harper Butler, PH.B. Yale University, 1890.	*Olean, N. Y.*	248 York st.
Perry Moore Caldwell, PH.B. Yale University, 1889.	*Wheeling, W. Va.*	36 Elm st.
Ralph Roger Clapp, PH.B. Yale University, 1890.	*Pawtucket, R. I.*	88 Wall st.
Edwin Kirk Dillingham, PH.B. Yale University, 1889.	*New Orleans, La.*	90 Wall st.
Harootune Enfiajian, PH.B. Yale University, 1889.	*Harpoot, Turkey.*	20 Insurance B'ld'g.
Oliver Cummings Farrington, M.S. Maine State College, 1888.	*Portland, Me.*	78 E.
Charles Addison Terry, PH.B. Yale University, 1871.	*New Haven, Conn.*	104 Liberty st.
Irving Fisher, B.A. Yale University, 1888.	*New Haven, Conn.*	119 Park st.
Matthew Griswold, Jr., PH.B. Yale University, 1888.	*Erie, Pa.*	A.
Elliott Proctor Joslin, B.A. Yale University, 1890.	*Oxford, Mass.*	1010 Chapel st.
Harvey Merrill Lawson, PH.B. Yale University, 1890.	*Union, Conn.*	56 N. S. H.
Thomas George Lee, M.D. University of Pa., 1886.	*New Haven, Conn.*	373 Crown st.
Frank Dodge Leffingwell, B.A. Yale University, 1887.	*Montclair, N. J.*	A.
Edwin Hoyt Lockwood, PH.B. Yale University, 1888.	*New Canaan, Conn.*	57 N. S. H.
William Ellison Lockwood, M.D. Yale University, 1885.	*New Haven, Conn.*	32 Pearl st.
Boynton Wells McFarland, PH.B. Yale University, 1890.	*New Haven, Conn.*	306 Lawrence st.
Frank Sherman Meara, B.A. Yale University, 1890.	*Cottage City, Mass.*	70 N. M.
Edwin Morrison, PH.B. Yale University, 188.	*Cincinnati, O.*	A.
Frank Russell Rich, PH.B. Yale University, 1890.	*New Haven, Conn.*	A.
Leonard Cutler Sanford, B.A. Yale University, 1890.	*New Haven, Conn.*	216 Crown st.

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Ernest Ellsworth Smith, PH.B. Yale University, 1888.	*New Haven, Conn.*	1018 Chapel st.
Percy Franklin Smith, PH.B. Yale University, 1888.	*New Haven, Conn.*	13 Home pl.
Erwin Starr Sperry, PH.B. Yale University, 1887.	*Ansonia, Conn.*	Ansonia.
John Clayton Tracy, PH.B. Yale University, 1890.	*Fair Haven, Conn.*	A.
Henry Lord Wheeler, PH.B. Yale University, 1890.	*Chicago, Ill.*	126 Wall st.

GRADUATE STUDENTS, 30.

UNDERGRADUATES.

SENIOR CLASS.

William Adams, Jr.,	*Scarsdale, N. Y.,*	43 College st.
Frederick Max Adler,	*New Haven, Conn.,*	127 Greene st.
Harris Walton Baker,	*Springfield, Mass.,*	90 Wall st.
Willis James Black,	*Bridgeport, Conn.,*	33 Wall st.
Burton Dickinson Blair,	*Collinsville, Conn.,*	36 Elm st.
Arthur Eli Booth,	*Peace Dale, R. I.,*	32 Wall st.
Joseph Douglas Brown,	*New York City,*	62 w.
Sterling Haight Bunnell,	*Stratford, Conn.,*	146 College st.
Brown Caldwell,	*Pittsburgh, Pa.,*	90 Wall st.
DeLancey Allen Cameron,	*Caledonia, N. Y.,*	219 York st.
Robert Hanna Carnahan,	*Fort Wayne, Ind.,*	88 Wall st.
Henry Albert Carpenter,	*Willimantic, Conn.,*	134 College st.
Francis Allen Clark,	*Plantsville, Conn.,*	70 Howe st.
Noyes Dwight Clark,	*Woodbridge, Conn.,*	642 Elm st.
Robert Lewis Coleman,	*San Francisco, Cal.,*	131 Grove st.
Lehman Adams Cooper,	*Hagerstown, Md.,*	131 Grove st.
Benedict Crowell,	*Cleveland, O.,*	152 Grove st.
Homer Stille Cummings,	*New Haven, Conn.,*	376 Whitney av.
Laurence Andrew Dodsworth,	*New York City,*	44 Elm st.
Robert Metcalf Dodsworth,	*Los Angeles, Cal.,*	512 George st.
Frederick James Easterbrook,	*New Haven, Conn.,*	82 York sq.
George Sherwood Eddy,	*Leavenworth, Kan.,*	62 w.
Wyatt Collier Estes,	*Memphis, Tenn.,*	154 Grove st.
George Chandler Forrest,	*Hartford, Conn.,*	133 College st.
Albert Francke,	*New York City,*	43 College st.
Frank Hamilton Funk,	*Bloomington, Ill.,*	1002 Chapel st.
Edward Everett Gates,	*Indianapolis, Ind.,*	88 Wall st.
Willis Blake Goodwin,	*Bangor, Me.,*	128 Wall st.
Henry Whitmore Gregory,	*Darien, Conn.,*	1001 Grand av.

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Lewis Winters Gunckel,	*Dayton, O.,*	36 Elm st.
William Pierson Hamilton,	*New York City,*	43 College st.
David Alexander Hays,	*Johnstown, N. Y.,*	248 York st.
Walter William Heffelfinger,	*Minneapolis, Minn.,*	131 Grove st.
Edwin Guy Helm,	*Peru, Ind.,*	310 Elm st.
John Williamson Herron, Jr.,	*Cincinnati, O.,*	128 High st.
Robert Gibson Hilton,	*Newburgh, N. Y.,*	248 York st.
Robert Massonneau Hoffman,	*Red Hook, N. Y.,*	248 York st.
Thomas Osborn Horton,	*Peconic, N. Y.,*	128 High st.
Robert Schuttler Hotz,	*Chicago, Ill.,*	248 York st.
David Lynde Huntington,	*San Diego, Cal.,*	158 York st.
Milton Cleaveland Isbell.	*Ansonia, Conn.,*	Ansonia
Theodore Caldwell Janeway,	*New York City,*	116 w.
Frederick William Jones, Jr.,	*New York City,*	43 College st.
George Coburn Kohler,	*Akron, O.,*	248 York st.
Augustus Frederick Kountze,	*Omaha, Nebr.,*	86 Wall st.
George Marcellus Landers, Jr.,	*New Britain, Conn.,*	43 College st.
Clifford Walter Leavenworth,	*Wallingford, Conn.,*	219 York st.
Daniel Alden Loring, Jr.,	*New York City,*	43 College st.
Charles Nassau Lowrie,	*Warrior's Mark, Pa.,*	134 College st.
George Eldredge McClellan,	*Woodstock, Conn.,*	43 College st.
David Magie Meeker,	*Newark, N. J.,*	1180 Chapel st.
George Wylie Mercer,	*Omaha, Nebr.,*	1002 Chapel st.
Harral Mulliken,	*Washington, D. C.,*	42 Elm st.
Gustave Munzesheimer,	*New York City,*	113 Wall st.
John Stevens Murdock,	*Westbrook, Conn.,*	Westbrook
Warren Bynner Nash,	*Brooklyn, N. Y.,*	42 Elm st.
John Colwell Neale,	*Kittanning, Pa.,*	337 Orange st.
Nathaniel Read Norton,	*Brooklyn, N. Y.,*	134 College st.
Stanley Hawken Pearce,	*Denver, Col.,*	43 College st.
Arthur Chaping Pease,	*Ellington, Conn.,*	64 Lake pl.
William Horace Pelton,	*Hartford, Conn.,*	88 Wall st.
George Nathaniel Prentiss,	*Watertown, Wisc.,*	132 Wall st.
Alfred Helm Preston,	*Omaha, Nebr.,*	88 Wall st.
Walter Gray Preston,	*Omaha, Nebr.,*	88 Wall st.
Milton Holley Robbins,	*Lakeville, Conn.,*	156 Grove st.
Eugene Boutelle Sanger,	*Bangor, Me.,*	36 Elm st.
Ennis Newton Searles,	*New Haven, Conn.,*	279 Sherman av.
John David Shattuck,	*Norwich, N. Y.,*	64 Lake pl.
Harry Hudson Shepard,	*New Haven, Conn.,*	409 Orange st.
George Monroe Sidenberg,	*New York City,*	124 Wall st.
George Milton Smith,	*Plantsville, Conn.,*	70 Howe st.
Thomas Cullen Bryant Snell,	*New Haven, Conn.,*	105 Wooster st.
Lewis Edwards Sparrow,	*Colchester, Conn.,*	92 York sq.
George Pratt Starkweather,	*New Haven, Conn.,*	N. H. Hospital
George Fetter Stickney,	*Buffalo, N. Y.,*	1161 Chapel st.
Charles Ferris Sturtevant,	*Cleveland, O.,*	43 College st.
Edward Owen Sutton,	*Springfield, Mass.,*	83 Grove st.

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Issa Tanimura,	*Tōkyō, Japan,*	67 Edgewood av.
Amasa Trowbridge,	*New Haven, Conn.,*	685 Orange st.
Edward VanIngen,	*New York City,*	131 Grove st.
Clark Greenwood Voorhees,	*New York City,*	133 College st.
Arvine Wales,	*Massillon, O.,*	131 Grove st.
William Ernest Walker,	*Chicago, Ill.,*	131 Grove st.
Edward Young Ware,	*St. Louis, Mo.,*	9 Library st.
Robert Karl Wehner, Jr.,	*New Haven, Conn.,*	1210 Chapel st.
Rudolph Michael Weyerhaeuser,	*Rock Island, Ill.,*	88 Wall st.
Henry Wick, Jr.,	*Cleveland, O.,*	42 Elm st.
Aras James Williams,	*Utica, N. Y.,*	42 Elm st.
Charles Morgan Wood,	*Dayton, O.,*	131 Grove st.
Pierre Jay Wurts,	*New Haven, Conn.,*	113 Whitney av.

SENIORS, 90.

JUNIOR CLASS.

Francis Mulliken Adams,	*New Haven, Conn.,*	459 Prospect st.
Wallace McKinney Alexander,	*Oakland, Cal.,*	250 York st.
Herbert Burr Atha,	*Newark, N. J.,*	1018 Chapel st.
Fred Murray Ayers,	*Indianapolis, Ind.,*	138 College st.
Walter Stanton Bailey,	*Brooklyn, N. Y.,*	37 Elm st.
William Atwater Baldwin,	*Lahaina, Maui, H. I.,*	250 York st.
Francis Edward Barbour,	*Montreal, Canada,*	226 Crown st.
Frank Harrison Barbour,	*Detroit, Mich.,*	226 Crown st.
Alfred Victor Barnes,	*Brooklyn, N. Y.,*	43 College st.
Joseph Bulkley Barnes,	*New York City,*	124 Wall st.
William Nicholas Beach,	*Orange, N. J.,*	42 Elm st.
Ben Roberts Bechtel,	*West Chester, Pa.,*	126 High st.
Charles Edmund Beeson,	*Uniontown, Pa.,*	131 Grove st.
Bartram Borden Boltwood,	*Castleton, N. Y.,*	137 Wall st.
Sherman Hoyt Bouton,	*Chicago, Ill.,*	92 York sq.
Waldo Clayton Briggs,	*New Haven, Conn.,*	18 Eld st.
William Henry Bronson,	*New York City,*	109 High st.
Harry Kilburn Brown,	*Denver, Col.,*	131 Grove st.
Otis Gridley Bunnell,	*Burlington, Conn.,*	58 Lyon st.
Lucius Lucine Button,	*Norwich, Conn.,*	157 York st.
Walter Lord Caldwell,	*Ongar, Essex, England,*	43 College st.
Robert Calhoun,	*Chicago, Ill.,*	131 Grove st.
George Flavius Campbell,	*Pittsfield, Mass.,*	49 Dixwell av.
Willard Rowe Carrol,	*Yalesville, Conn.,*	Yalesville
Charles Butler Chandler,	*Hartford, Conn.,*	114 High st.
John Charles Clark	*Cincinnati, O.,*	397 Temple st.
Walter Ellsworth Coe,	*Meriden, Conn.,*	60 Grove st.
Wesley Roswell Coe,	*Middlefield, Conn.,*	West Haven
Harry Cone Collins,	*Springfield, Mass.,*	395 Temple st.
Egbert Wheeler Cornwall,	*Patterson, N. Y.,*	397 Crown st.
Wilbur Fisk Day, Jr.,	*New Haven, Conn.,*	310 York st.

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Thomas Denny, Jr.,	*New York City*,	130 Wall st.
Duncan Steuart Ellsworth,	*Penn Yan, N. Y.*,	46 College st.
Samuel Fray,	*Bridgeport, Conn.*,	371 Crown st.
Claude Gignoux,	*Monroe, N. Y.*,	285 York st.
Simon Phillip Goodhart,	*New Haven, Conn.*,	221 Crown st.
George Arthur Gordon,	*Savannah, Ga.*,	226 Crown st.
J. Avery Gould,	*Aurora, N. Y.*,	131 Grove st.
Andrew Barbey Graves,	*Brooklyn, N. Y.*,	130 Wall st.
Joseph Sutton Green,	*Raynham, Mass.*,	405 Temple st.
Harry Priest Greené,	*Amsterdam, N. Y.*,	126 High st.
Thomas Strong Griffing,	*Setauket, N. Y.*,	393 Temple st.
David Cullen Griggs,	*Waterbury, Conn.*,	248 York st.
Herbert William Hamlin,	*Chicago, Ill.*,	131 Grove st.
John Henry Hammond, Jr.,	*St. Paul, Minn.*,	43 College st.
Josiah Harmar,	*Philadelphia, Pa.*,	395 Temple st.
Norman Dwight Harris,	*Chicago, Ill.*,	679 Chapel st.
Samuel Atkinson Harsh,	*Denver, Col.*,	131 Howe st.
Frank Lockwood Hatch,	*Springfield, Ill.*,	9 Library st.
Thomas Simmons Homans,	*Springfield, Mass.*,	395 Temple st.
Henry Dwight Hunt,	*Columbia, Conn.*,	81 Wall st.
Gustave Erwin Huttelmaier,	*Knoxville, Tenn.*,	192 Grove st.
Harry Helmer Jackson,	*Chicago, Ill.*,	106 Wall st.
Huson Taylor Jackson,	*Allegheny City, Pa.*,	88 Wall st.
Edward Wilson Johnstone,	*Connellsville, Pa.*,	126 Wall st.
Walter Woodruff Keith,	*Chicago, Ill.*,	131 Grove st.
James Hugh Kimball,	*Chicago, Ill.*,	128 High st.
James Moffatt Knapp,	*Auburn, N. Y.*,	65 w.
Charles Thomas Kountze,	*Omaha, Nebr.*,	86 Wall st.
Henry Edgar Lane,	*Killingworth, Conn.*,	81 Wall st.
William Walter Law, Jr.,	*Yonkers, N. Y.*,	1002 Chapel st.
Joseph Lesinsky,	*New York City*,	393 Temple st.
Isaac Chauncey McKeever,	*New York City*,	226 Crown st.
Edward McVicker,	*Collinsville, N. Y.*,	42 Elm st.
James Stephen Maher,	*New Haven, Conn.*,	203 East st.
Denis James Maloney,	*New Haven, Conn.*,	34 Ferry st.
Frank Edwin Mandel,	*Chicago, Ill.*,	107 Wall st.
Richard Fisher Manning,	*Brooklyn, N. Y.*,	68 Wall st.
Rober Valentine Massey,	*Dover, Del.*,	42 Elm st.
Harold Chauncey Matthews,	*New York City*,	159 Elm st.
Gardner Meeker,	*Newark, N. J.*,	161 York st.
Charles Wilson Merrels,	*New Haven, Conn.*,	24 Pearl st.
Reuben Miller, Jr.,	*Pittsburgh, Pa.*,	7 Library st.
Fred Mold,	*Blosburg, Pa.*,	138 St. John st.
Theophilus Nelson,	*Bridgeport, Conn.*,	371 Crown st.
Edward Sherman Nettleton,	*New Haven, Conn.*,	642 Elm st.
George Eli Nettleton,	*New Haven, Conn.*,	333 Exchange st.
Charles Henry Nichols,	*Branford, Conn.*,	Branford
Louis Septimus Owsley,	*Chicago, Ill.*,	131 Grove st.

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Richard Francis Pearce,	*Denver, Col.*,	130 Wall st.
Montague Elias Perkins,	*Bristol, Conn.*,	295 York st.
Roger Swope Pitkin,	*Chicago, Ill.*,	285 York st.
Miles Albion Pond,	*Torrington, Conn.*,	57 Grove st.
John Keeler Punderford,	*New Haven, Conn.*,	75 Howe st.
Harry Ralsten Quinn,	*Milton, Vt.*,	101 Greene st.
Charles Cornwell Ramsdell,	*New Haven, Conn.*,	104 Wall st.
George Wolf Reily, Jr.,	*Harrisburg, Pa.*,	347 York st.
William Reynolds Ricketts,	*Wilkes-Barre, Pa.*,	36 Elm st.
Charles Marcy Robinson,	*Middletown, Conn.*,	305 George st.
Albert B. Rogowski,	*New Haven, Conn.*,	318 Crown st.
Frank Herbert Sampson,	*Boston, Mass.*,	159 Elm st.
William Parker Sargent,	*Chicago, Ill.*,	137 Wall st.
Albert Leslie Sessions,	*Bristol, Conn.*,	248 York st.
Edward Helfenstein Simmons,	*St. Louis, Mo.*,	131 Grove st.
Arthur Jarvis Slade,	*New York City*,	248 York st.
Ralph William Sprague,	*Chicago, Ill.*,	36 Elm st.
Alix Welch Stanley,	*New Britain, Conn.*,	42 Elm st.
Paul Sterling,	*Bridgeport, Conn.*,	152 Grove st.
Harry Taylor Stoddart,	*Wilkes-Barre, Pa.*,	38 Lynwood st.
James Graham Stokes,	*New York City*,	130 Wall st.
Worthington Smith Telford,	*St. Albans, Vt.*,	389 Temple st.
Isaac Biddle Thomas,	*West Chester, Pa.*,	159 Elm st.
Charles Stewart Towle,	*New York City*,	131 Grove st.
John Henry Vought,	*Buffalo, N. Y.*,	131 Grove st.
Percy Talbot Walden,	*Brooklyn, N. Y.*,	86 w.
Walter Frederick Waring,	*Savannah, Ga.*,	131 Grove st.
Lauren Kellogg Warnick,	*Amsterdam, N. Y.*,	248 York st.
Isaac Weil,	*San Francisco, Cal.*,	124 Wall st.
Charles Weiser,	*York, Pa.*,	86 w.
Alfred Pelton Wheeler,	*Meriden, Conn.*,	59 Grove st.
Edward Lancaster Whittemore,	*Fort Union, N. M.*,	213 Wooster st.
Charles Mallory Williams,	*Brooklyn, N. Y.*,	152 Grove st.
Philip Keeney Williams,	*Hartford, Conn.*,	114 High st.
John Baker Winstandley,	*Bedford, Ind.*,	88 Wall st.
Walter Abbott Wood, Jr.,	*Hoosac Falls, N. Y.*,	433 Temple st.
William Bassett Woodward,	*Denver, Col.*,	131 Grove st.
Vincent Jay Youmans,	*Mount Vernon, N. Y.*,	405 Temple st.
Clarence Clark Zantzinger,	*Philadelphia, Pa.*,	38 Elm st.

JUNIORS, 118.

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FRESHMAN CLASS.

Roger Cook Adams,	*New Haven, Conn.,*	459 Prospect st.
Frank Alvan Alexander,	*Oakland, Cal.,*	154 Grove st.
Harris Platt Allen,	*New York City,*	136 Howe st.
William Bradford Allen,	*New Haven, Conn.,*	284 Orange st.
Mortimer Harmount Alling,	*New Haven, Conn.,*	238 Orchard st.
William Marvin Armstrong,	*Brooklyn, N. Y.,*	126 Wall st.
James Howard Bailey,	*Brooklyn, N. Y.,*	126 Wall st.
Anson Baldwin,	*Yonkers, N. Y.,*	389 Temple st.
Joseph Henry Bamberg,	*New Haven, Conn.,*	75 Nichol st.
Donn Barber,	*New York City,*	393 Temple st.
Morris Hugus Beall,	*Omaha, Nebr.,*	114 High st.
James Beach Beckett,	*Western Springs, Ill.,*	411 Temple st.
Charles Pool Belden,	*Chicago, Ill.,*	289 York st.
William Bart Berger,	*Denver, Col.,*	90 Wall st.
Walter Spencer Billard,	*Meriden, Conn.,*	61 Grove st.
Oliver Chandler Billings,	*New York City,*	133 College st.
Orland Rossini Blair,	*New Britain, Conn.,*	59 Grove st.
Robert Sylvester Blakeman,	*Stratford, Conn.,*	146 College st.
Lawrence Thornton Bliss,	*New York City,*	132 Wall st.
Harry Lattimer Bloodgood,	*New York City,*	242 York st.
John Merrill Boden,	*Bradford, Pa.,*	1076 Chapel st.
Almon Farrel Bowen,	*Waterbury, Conn.,*	65 Grove st.
Joseph Judson Brooks, Jr.,	*Pittsburgh, Pa.,*	391 Temple st.
Walter Frank Brown,	*New London, Conn.,*	226 Crown st.
Nelson Beardsley Burr,	*Auburn, N. Y.,*	132 Wall st.
Alexander James Campbell,	*San Francisco, Cal.*	65 Grove st.
James Edward F. Campbell,	*New York City,*	114 High st.
Sheldon Cary,	*Cleveland, O.,*	1010 Chapel st.
John Davenport Cheney,	*So. Manchester, Conn.,*	226 Crown st.
George Clifford Clark,	*Terryville, Conn.,*	22 Lynwood st.
Herman Daggett Clark, Jr.,	*New Haven, Conn.,*	13 Trumbull st.
John Williams Coe,	*Meriden, Conn.,*	60 Grove st.
William Garrard Comly,	*Indianapolis, Ind.,*	141 High st.
Henry Failing Conner,	*Portland, Oregon,*	146 College st.
Lester Wiggins Day,	*Louisville, Ky.,*	407 Temple st.
Hughes Dayton,	*Southport, Conn.,*	84 Wall st.
James Laird deVou,	*Wilmington, Del.,*	133 College st.
James Dudley Dewell, Jr.,	*New Haven, Conn.,*	400 Orange st.
Fredrick Wead Drury, Jr.,	*St. Louis, Mo.,*	425 Temple st.
Leroy Church Dupee,	*Chicago, Ill.,*	67 Whalley av.
Ernest Bradford Ellsworth,	*Hartford, Conn.,*	397 Temple st.
Albert DeWolf Erskine,	*Chicago, Ill.,*	407 Temple st.
Jason Evans,	*Morristown, N. J.,*	395 Temple st.
Mark Ewing,	*St. Louis, Mo.,*	124 Wall st.
Joseph Brooks Fair,	*Chicago, Ill.,*	40 Elm st.
Smith Farley Ferguson,	*Troy, N. Y.,*	335 Orange st.

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Howard Judson Fish,	*Pasadena, Cal.*,	19 Wall st.
Marc Milton Fishel,	*New York City*,	114 High st.
James Henry Follis,	*San Francisco, Cal.*,	159 Elm st.
Frederick Luther Ford,	*North Branford, Conn.*,	313 Grand av.
George Congdon Fouse,	*Washington, D. C.*,	8 Trumbull st.
Edward Levi Fox,	*New Haven, Conn.*,	117 Park st.
Arthur Graham Freeland,	*New York City*,	150 Grove st.
Richard Garlick,	*Youngstown, O.*,	109 Elm st.
Albert Dewitt Gibbs,	*Chicago, Ill.*,	31 Trumbull st.
Harry Smythe Gordon,	*Cleveland, O.*,	1010 Chapel st.
Gaston Gunter,	*Montgomery, Ala.*,	314 York st.
Robert Ezra Hall,	*Hartford, Conn.*,	124 Wall st.
Samuel Mowbry Hammond, Jr.,	*Torrington, Conn.*,	382 George st.
Thomas King Hanna, Jr.,	*Kansas City, Mo.*,	389 Temple st.
Howard Joseph Haslehurst,	*Brooklyn, N. Y.*,	86 Wall st.
Arthur Stephen Hawley,	*New Haven, Conn.*,	20 Gill st.
Charles Borland Hill,	*Montgomery, N. Y.*,	409 Temple st.
Louis Warren Hill,	*St. Paul, Minn.*,	1076 Chapel st.
Frank Elijah Hine,	*Milford, Conn.*,	55 Trumbull st.
Charles Wilcox Hitchcock,	*Cleveland, O.*,	233 York st.
Sidney Stone Holt,	*New Haven, Conn.*,	71 Dwight st.
William Thomas Hildrup Howe,	*Cazenovia, N. Y.*,	215 Norton st.
Hampton Howell,	*Brooklyn, N. Y.*,	86 Wall st.
Phelps Buttolph Hoyt,	*Chicago, Ill.*,	391 Temple st.
William Churchill Hungerford,	*New Britain, Conn.*,	38 Elm st.
George Albert Hutchinson,	*Chicago, Ill.*,	136 College st.
Charles Anthony Ingersoll,	*New Haven, Conn.*,	24 Elm st.
Harry Churchill January,	*St. Louis, Mo.*,	395 Temple st.
William Rankin Johnston,	*Shippensburg, Pa.*,	228 Crown st.
Thomas O'Conor Jones,	*Pittsburgh, Pa.*,	132 Wall st.
Charles Oscar Kalman,	*St. Paul, Minn.*,	124 Wall st.
John Hume Kedzie, Jr.,	*Evanston, Ill.*,	40 Elm st.
William Lansing, Jr.,	*Albany, N. Y.*,	335 Orange st.
Elmer Arthur Lawbaugh,	*Opechee, Mich.*,	255 Crown st.
Burton Leonard Lawton,	*Meriden, Conn.*,	Meriden.
Louis Cicero Lawton,	*Brooklyn, Conn.*,	55 Prospect st.
Joseph Lentilhon, Jr.,	*New York City*,	391 Temple st.
Harry Blakeman Lewis,	*New Haven, Conn.*,	438 George st.
Frank Allen Little,	*Meriden, Conn.*,	Meriden.
Samuel Whiter McCaulley,	*Wilmington, Del.*,	397 Temple st.
Vance Criswell McCormick,	*Harrisburg, Pa.*,	133 College st.
Clifford Whiting McGee,	*Plainfield, N. J.*,	146 College st.
William McKell,	*Chillicothe, O.*,	1010 Chapel st.
Charles Eugene McLane,	*Baltimore, Md.*,	109 Wall st.
Fred Bogart McMullen,	*Picton, Ontario, Can.*,	419 Temple st.
Herbert Yarwood McMullen,	*Picton, Ontario, Can.*,	419 Temple st.
Winslow Mallery,	*Cincinnati, O.*,	395 Temple st.
Leonard Mandel,	*Chicago, Ill.*,	137 College st.

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Edward Anthony Mitchell,	*New Haven, Conn.*,	79 Trumbull st.
Lysander Royster Moore, Jr.,	*Kansas City, Mo.*,	389 Temple st.
Henry Hotchkiss Murray,	*Viola, Del.*,	54 Garden st.
Oliver Peter Nicola,	*Cleveland, O.*,	132 Wall st.
Fred Henry Osborne,	*New Haven, Conn.*,	223 Bradley st.
Samuel Cupples Pierce,	*St. Louis, Mo.*,	395 Temple st.
Edward Harrison Post,	*Wilkes-Barre, Pa.*,	36 Elm st.
Herbert Leroy Potter,	*North Guilford, Conn.*,	15 Rose st.
Joseph Hyde Pratt,	*West Hartford, Conn*,	397 Temple st.
Wiley Byrd Raymond,	*Wyoming, O.*,	391 Temple st.
Harry Parks Ritchie,	*St. Paul, Minn.*,	114 High st.
Allan Appleton Robbins,	*New York City*,	109 Wall st.
Ralph Stewart Robinson,	*Colchester, Conn.*,	255 Ferry st.
Samuel Moorhead Russell,	*Bedford Springs, Pa.*,	120 High st.
Alexander Kirkwood Sedgwick,	*Ishpeming, Mich.*,	1090 Chapel st.
George Bargh Sedgwick,	*Ishpeming, Mich.*,	1090 Chapel st.
DeForest Lee Selover,	*Cleveland, O.*,	55 Trumbull st.
Edward Olin Smith,	*Springfield, Mass.*,	109 Elm st.
Lewis Motter Smith,	*St. Joseph, Mo.*,	126 Wall st.
Frederick Clarence Spencer,	*Old Saybrook, Conn.*,	411 Temple st.
Alfred Hull Stevens,	*Clinton, Conn.*,	117 Park st.
William Petheric Stevens,	*Detroit, Mich.*,	425 Temple st.
Raymond French Stoddard,	*Milford, Conn.*,	Milford.
Charles Bradley Stoughton, Jr.,	*New Haven, Conn.*,	339 Prospect st.
Frederick Enos Stow,	*Plantsville, Conn.*,	70 Howe st.
Richard Pearson Strong,	*Atlanta, Ga.*,	200 Grove st.
Henry Augustus Stults,	*Savannah, Ga.*,	409 Temple st.
Richard Schoonmaker Suydam,	*Allegheny City, Pa.*,	9 Library st.
Edward Coleman Talcott,	*Hartford, Conn.*,	133 College st.
Willliam Buffum Thompson,	*Pasadena, Cal.*,	19 Wall st.
Walter Henry Tilton,	*New Haven, Conn.*,	235 Dixwell av.
John Stewart Tritle,	*Prescott, Arizona*,	407 Orange st.
Albert Leverett VanHuyck,	*Lee, Mass.*,	17 Home pl.
McLane VanIngen,	*New York City*,	425 Temple st.
Paul Wentworth Webster,	*Cleveland, O.*,	83 Grove st.
Frederick Brown Wells,	*Minneapolis, Minn.*,	158 Whitney av.
Robert William Whitehead,	*Wakefield, Mass.*,	223 York st.
Howard Dudley Wiggins,	*Indianapolis, Ind.*,	141 High st.
Ira Edward Wight,	*New Orleans, La.*,	389 Temple st.
Eugene Robbins Willard,	*Hartford, Conn.*,	146 College st.
Wallace Charles Winter,	*St. Paul, Minn.*,	114 High st.
Ernest Strong Witbeck,	*Detroit, Mich.*,	133 College st.
Harry Philip Womelsdorf,	*Pottsville, Pa.*,	130 Wall st.

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SPECIAL STUDENTS NOT CANDIDATES FOR A DEGREE.

John Harry Frambach,	*Kaukauna, Wisc.*,	138 Court st.
James Tracy Hill,	*Chicago, Ill.*,	43 College st.
William Whittemore Low,	*New Haven, Conn.*,	213 Wooster st.
William Herbert Krumm,	*Columbus, O.*	185 Bradley st.
Arthur Stein,	*Chicago, Ill.*,	107 Wall st.
George Curtis Treadwell,	*Albany, N. Y.*,	184 York st.

SPECIAL STUDENTS, 6.

SUMMARY.

Graduates,	29
Seniors,	90
Juniors,	118
Freshmen,	137
Special Students,	6
	381

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SHEFFIELD SCIENTIFIC SCHOOL.

OBJECTS.

THE SHEFFIELD SCIENTIFIC SCHOOL is devoted to instruction and researches in the mathematical, physical and natural sciences, with reference to the promotion and diffusion of science, and also to the preparation of young men for such pursuits as require especial proficiency in these departments of learning. It is one of the Departments of Yale University, like the law, medical, theological, and art schools, having its separate funds, buildings, teachers and regulations, but governed by the Corporation of Yale College, which appoints the professors and confers the degrees. It is, in part, analogous to the academic department, or classical college, and, in part, to the professional schools.

The instruction is intended for two classes of students :—

I. Graduates of this or of other colleges, and other persons qualified for advanced or special scientific study.

II. Undergraduates who desire a training chiefly mathematical and scientific, in less part linguistic and literary, for higher scientific studies, or for various other occupations to which such training is suited.

HISTORY AND ORGANIZATION.

The school was commenced in 1847. In 1860, a convenient building and considerable endowment were given by Joseph E. Sheffield, Esq., of New Haven, whose name at the repeated request of the Corporation of Yale College, was afterwards attached to the foundation. Mr. Sheffield afterward frequently and munificently increased his original gifts.

In 1863, by an act of the Connecticut Legislature, the national grant for the promotion of scientific education (under the congressional enactment of July, 1862), was given to this department of Yale University. Since that time, and especially since the autumn of 1868, numerous liberal gifts have been received from

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the citizens of New Haven, and from other gentlemen in Connecticut and New York, for the endowment of the School, and the increase of its collections.

The action of the State led to the designation by law of a State Board of Visitors, consisting of the Governor, Lieutenant-Governor, three senior Senators, and the Secretary of the State Board of Education: and this Board, with the Secretary of the Scientific School, is also the Board for the appointment of students to hold the State scholarships.

The Governing Board consists of the President of Yale University, the Director of the school, and the professors who are permanently attached to it. There are several other instructors associated with them, a number of whom are connected with other departments of the University.

BUILDINGS AND APPARATUS.

The three buildings in which the work of instruction in the Scientific School is mainly carried on, are called Sheffield Hall, North Sheffield Hall, and Sheffield Biological Laboratory; but instruction in Mineralogy, Geology, and Zoology, is given in the Peabody Museum, and Free Hand Drawing in the Art School. These buildings contain a large number of recitation and lecture rooms, a hall for public assemblies and lectures, chemical, biological, and metallurgical laboratories, besides studies for some of the professors, where their private technical libraries are kept.

The following is a summary statement of the collections belonging to the School:

1. Laboratories and Apparatus in Chemistry, Metallurgy, Physics and Zoology.
2. Metallurgical Museum of Ores, Furnace Products, etc.
3. Agricultural Museum of Soils, Fertilizers, useful and injurious insects, etc.
4. Collections in Zoology.
5. Astronomical Observatory, with an equatorial telescope by Clark and Sons, of Cambridge, a meridian circle, etc.
6. A collection of Mechanical Apparatus, constituting the "Collier Cabinet."
7. Models in Architecture, Geometrical Drawing, Civil Engineering, Topographical Engineering and Mechanics; diagrams adapted to public lectures; instruments for field practice.
8. Maps and Charts, topographical, geological, hydrographical, etc.

The herbarium of Professor Brewer is deposited in the buildings. Professor Eaton's herbarium near at hand, is freely accessible. Students also have access to the various laboratories and collections in Natural Science in the Peabody Museum and in that building is given the instruction in Zoology and Geology.

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Students are also admitted to the University and Society libraries, the College Reading Room, the School of the Fine Arts and the Gymnasium.

THE LIBRARY.

The special technical library of the Scientific School consists of about five thousand volumes. Included in this is the "Hillhouse Mathematical Library" of twenty-four hundred volumes, collected during a long series of years by Dr. William Hillhouse, and in 1870 purchased and presented to the institution by Mr. Sheffield. A catalogue of this collection forms a supplement to the Annual Report of the Governing Board of 1870. All the prominent scientific journals of this country and of Europe, together with the proceedings of foreign academies, and scientific societies, can be found either in this library or in the University Library, to which students have access. A Chemical Library is also attached to the Chemical Department in Sheffield Hall.

INSTRUCTION FOR GRADUATE AND SPECIAL STUDENTS.

Persons who have gone through undergraduate courses of study here or elsewhere, may avail themselves of the facilities of the School for more special professional training in the physical sciences and their applications; gaining in one, two, or three years, the degree of BACHELOR OF PHILOSOPHY or, in two additional years of Engineering study, that of CIVIL ENGINEER or of MECHANICAL ENGINEER.

Or, engaging in studies of a less exclusively technical character, they may become candidates for the degree of DOCTOR OF PHILOSOPHY. The instruction in such cases will be adapted to the particular needs and capacities of each student, and may be combined with that given by the graduate instructors in other departments of the University. This degree is conferred upon those who, having already taken a Bachelor's degree, engage as students in the Department of Philosophy and the Arts for not less than two years in assiduous and careful study. It is not given upon examination to those whose studies are pursued elsewhere. The requirements for it will in some cases exact of the

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student more than two years of post-graduate labor, especially so, wherever the course of undergraduate study has been, as in the Scientific School, of less than four years. The candidate must pass a satisfactory final examination, and present a thesis giving evidence of high attainment in the branches of knowledge to which he has attended. A good knowledge of Latin, German, and French will be required in all cases, unless, for some exceptional reason, the candidate be excused by the Faculty. The graduating fee is ten dollars.

Subjects likely to receive special attention are suggested as follows:

Professor DuBois, in the principles of thermodynamics, and utilization of heat as a source of power.

Professor Richards, in mechanical engineering.

Professor Hastings, in selected subjects in physics, and guidance in laboratory work.

Professor Brush and Professor S. L. Penfield, in the analysis and determination of mineral species, and in descriptive mineralogy.

Professor Johnson, in theoretical, analytical, and agricultural chemistry.

Professor Brewer, in agriculture and forest culture and in physical geography.

Professor Clark, in definite integrals, differential equations, analytical mechanics, the theory of numerical approximation, with the method of least squares.

Professor Eaton, in structural and systematic botany, with reference to both flowering and cryptogamous plants.

Professor Verrill, and Professor Smith, in zoology, comparative anatomy, and geology.

Professor Chittenden, in Physiological Chemistry and Experimental toxicology.

Professor H. L. Wells and Professor S. L. Penfield, Analytical Chemistry, including a systematic course in Qualitative Analysis; a systematic course in Quantitative Analysis, and such special branches of Quantitative Analysis as are applied to Mineralogy and various departments of Metallurgy.

Professor S. L. Penfield in Crystallography.

The same courses of study are open, for a longer or shorter time, to graduate students who do not desire to become candidates for a degree.

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Students who have taken the degree of Bachelor of Philosophy, may obtain the degree of CIVIL or of MECHANICAL ENGINEER at the end of two academical years, by pursuing the following higher course of study and professional training.

The course of study for the degree of CIVIL ENGINEER will comprise—

1. Higher Calculus, Higher Geometry. Theory of Numerical Operations.
2. Analytical Mechanics. Mechanics applied to engineering.
3. A Course of Constructions and Designs. Projects.
4. Practical Astronomy, with use of instruments, computations, etc.

The course will occupy one year.

To secure the requisite amount of professional knowledge and practice, the candidate will be required to furnish a comprehensive report of the results of an examination into the existing condition of some special line of constructive art; or to present proper evidence that he has had actual charge in the field, for several months, of construction or surveying parties, or held some responsible position deemed equivalent to this.

An elaborate design must also be submitted of some projected work of construction, based upon exact data obtained from careful surveys made by the candidate, and comprising all the requisite calculations and the necessary detailed drawings, and accompanied by full specifications of the work to be done and the requirements to be met by the contractor.

The fee for this degree is five dollars.

The course of study for the degree of MECHANICAL ENGINEER will comprise—

1. Higher Calculus, Higher Geometry. Theory of Numerical Operations.
2. General Principles of Dynamics (Analytical Mechanics), including special application of these Principles to Dynamic Problems.
3. Construction of Machines. Designs.
4. Preparation of theses on special objects in Mechanical Engineering.

During the second year, candidates will be permitted to employ such portion of their time as may be deemed advisable or necessary in the examination of engineering works and manufacturing establishments, and may also have the privilege of entering upon professional practice, provided it is done with the knowledge and consent of the Professor of Mechanical Engineering, and under

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such circumstances as shall appear to him to be favorable to professional progress.

An elaborate thesis on some professional subject, with an original design, or project, accompanied by proper working drawings, will be required at the end of the second year.

The fee for this degree is five dollars.

SPECIAL STUDENTS.—For the benefit of those who, being fully qualified, desire to pursue particular studies without reference to the obtaining of a degree, special or irregular students are received in most of the departments of the School; not, however, in the Select Course or in the Freshman Class.

It should be distinctly understood that these opportunities are not offered to persons who are incompetent to go on with the special studies pursued by the regular classes, but are designed to aid those who, having received a sufficient preliminary education elsewhere, desire to increase their proficiency in special branches.

INSTRUCTION FOR UNDERGRADUATE STUDENTS.

TERMS OF ADMISSION.—Candidates must be not less than fifteen years of age, and must bring satisfactory testimonials of moral character from their former instructors or other responsible persons.

For admission to the Freshman Class the student must pass a satisfactory examination in the following subjects:

English—including grammar, spelling, and composition. In grammar, Whitney's Essentials of English Grammar, or an equivalent.

History of the United States.

Geography.

Latin—(1) Simple exercises in translating English into Latin, together with the elements of Latin Grammar. (2) Caesar—six books of the Gallic War, or their equivalent. (After September, 1891, there will be substituted for the six Books of Caesar, four books of Caesar's Gallic War and the first two books of Virgil's Aeneid, for which, without special application, no equivalent will be accepted.)

Arithmetic—Fundamental Operations, Least Common Multiple, Greatest Common Divisor, Common and Decimal Fractions, Denominate Numbers, including the Metric System of Weights and Measures; Percentages, including Interest, Discount, and Commission; Proportion, Extraction of the Square and Cube Roots.

Algebra—Fundamental Operations, Fractions, Equations of the First Degree, with one or several unknown quantities; Inequalities, Ratio and Proportion, Powers and Roots, including the theory of Exponents, the Binomial Formula, for an Entire Exponent, and the transformation and Reduction of Radicals;

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Equations of the Second Degree, Progressions, Continued Fractions, Permutations and Combinations, the Doctrine of Limits, the Nature of Series, the Method of Indeterminate Coefficients, Fundamental Properties of Logarithms, Compound Interest and Annuties.

Geometry—Plane, Solid and Spherical; including fundamental notions of Symmetry, and examples of Loci and Maxima and Minima of Plane Figures,—so much, for example, as is contained in Newcomb's Geometry, exclusive of the chapters on the Ellipse, Hyperbola, and Parabola.

Trigonometry—including the Analytical Theory of the Trigonometrical Functions, and the usual formulae; the Construction and Use of Trigonometrical Tables; and the Solution of Plane Triangles:—so much, for example, as is contained in the first six chapters of Newcomb's larger Trigonometry and in Arts. 75–78 of chapter viii, with the explanation of the first five tables in Newcomb's five-figure Logarithmic and Trigonometric Tables, which are furnished at the examination in New Haven.

While no entrance examination is held in the *History of England*, candidates for admission are urgently advised to make themselves as familiar as possible with that subject, as a knowledge of it is essential to the most successful prosecution of some of the studies of the course.

Candidates will be allowed the option of passing on the above-named subjects in two successive years. In such cases they must present themselves for examination at the June examination of the first year in the following subjects or parts of subjects: *History of the United States, Geography, Arithmetic, Plane Geometry, and Algebra to Quadratic Equations.*

In order to have this preliminary examination counted, candidates must pass satisfactorily on four of the subjects; and notice of the intention to divide the examination must be given to Professor George J. Brush, Director of the School, on or before June 15.

In his preparation in GEOMETRY, the candidate should, as far as practicable, have suitable exercises in proving simple theorems and in solving simple problems for himself. It is important, too, that he should be accustomed to the numerical application of geometric principles, and especially to the prompt recollection and use of the elementary formulæ of mensuration. In TRIGONOMETRY he should be exercised in applying the usual formulae to a variety of simple reductions and transformations, including the solution of trigonometrical equations. Readiness and accuracy in trigonometrical calculations are also of prime importance to the candidate. If the use of logarithms is postponed in his preparation till Trigonometry is taken up (which is by no means necessary or advisable), he should then have abundant applications of them to all forms of calculation occurring in ordinary practice, as well as to those appearing in the solution of triangles. Finally, in all his calculations, he should study the art of neat and orderly arrangement.

In LATIN the student should have such continued training in parsing as shall make him thoroughly familiar with declensions and conjugations, and with the

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leading principles of syntax. To secure these results more effectually, the requirement has been adopted of simple exercises in translating English into Latin. As this course of exercises is designed solely as a preparation for reading, it should be begun at the earliest stage of Latin study. A very large proportion of the deficiencies in the Latin examinations for several years past has been due to the neglect of the suggestions of this paragraph, and to the attempt to read a Latin author with totally inadequate grammatical preparation.

The examinations for admission in 1891 take place at North Sheffield Hall on Thursday, Friday, and Saturday, June 25, 26, 27 (beginning at 9 A. M. on Thursday); and on Tuesday and Wednesday, September 22, 23 (beginning at 9 A. M. on Tuesday).

In general, examinations for admission to the Freshman Class of the *next* year can be held only in June and September as specified: if in any case sufficient reason exists for an exception to this rule, a special fee (not exceeding fifty dollars) will be charged.

In 1891, examinations (for the Freshman Class only) will also be held in Concord and Exeter, N. H., in Andover, Mass., in Norwich, Conn., in New York City, in Albany, in Buffalo, in Chicago, in Cleveland, in Cincinnati, and in San Francisco (beginning on Thursday, June 25, at 9 A. M.), at places to be announced in local newspapers of the day previous. Candidates who propose to be present are requested to send their names to Professor George J. Brush, Director of the School, before June 15. A fee of five dollars will be charged for admission to the examinations outside of New Haven.

All candidates for advanced standing, *whether from other colleges or not*, are examined in addition to the preparatory studies, in those studies already pursued by the class which they wish to enter. Certificates of standing elsewhere cannot be accepted in place of these examinations, although they may be taken into account as collateral evidence of fitness for admission. No one can be admitted as a candidate for a degree, later than at the beginning of the Senior year.

COURSES OF INSTRUCTION, occupying three years, are arranged to suit the requirements of various classes of students. The first year's work is the same for all; for the last two years, the instruction is chiefly arranged in Special Courses. The Special Courses most distinctly marked out are the following:

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(*a.*) In Chemistry; (*b.*) In Civil Engineering;
(*c.*) In Mechanical Engineering;
(*d.*) In Agriculture: (*e.*) In Natural History;
(*f.*) In Biology preparatory to Medical studies;
(*g.*) In studies preparatory to Mining and Metallurgy;
(*h.*) In select studies preparatory to other higher studies.

The arrangement of studies is indicated in the annexed scheme. A fuller statement of the methods and character of the instruction will be found below. Unless otherwise specified, the number of hours given means hours per week.

FRESHMAN YEAR: INTRODUCTORY TO ALL THE COURSES.

FIRST TERM:—*German*—Whitney's Grammar and Reader, 3 hrs. *English*—Lounsbury's History of the English Language, 1 hr.; Exercises in Composition. *Mathematics*—The Derivatives of Algebraic Functions; Fundamental Properties of Equations; Plane Analytical Geometry; 3 hrs. *Physics*—Recitations, 2 hrs., with experimental lectures. 2 hrs. *Chemistry*—Mixter's; Recitations, 2 hrs; laboratory practice, 2 hrs. *Elementary Drawing*—Practical Lessons in the Art School, 3 hrs.

SECOND TERM:—*Language, Physics and Chemistry*—as stated above. *Mathematics*—Plane Analytical Geometry, continued, 3 hrs. *Physical Geography*—8 Lectures during the term. *Botany*—Gray's Lessons, 3 hrs. *Drawing*—Principles of Orthographic Projection; Isometric Drawing with application to drawing from models and structures, and isometric construction of objects from their orthographic projections; Projections of Shadows; Shading and tinting; Sections; Developments and Intersections of Surfaces; 4 hrs.

For the Senior and Junior years, the students select for themselves one of the following Courses:

(a.) IN CHEMISTRY.

JUNIOR YEAR.

FIRST TERM:—*Organic Chemistry*—Lectures and Recitations, 2 hrs. *Qualitative Analysis*—Recitations, 2 hrs.; Laboratory Practice, 20 hrs.; Blowpipe Practice and Determinative Mineralogy, 4 hrs. *German*—3 hrs. *French*—3 hrs.

SECOND TERM:—*Organic Chemistry*—Lectures and Recitations, 2 hrs. *Quantitative Analysis*—Laboratory Practice, 20 hrs.; Recitations, 2 hrs. *Mineralogy*—Blowpipe Analysis and determination of species, 4 hrs.; Lectures in Crystallography and Descriptive Mineralogy, 2 hrs. *German*—3 hrs. *French*—3 hrs.

SENIOR YEAR.

FIRST TERM:—*Organic and Theoretical Chemistry*—Recitations and Lectures, 2 hrs. *Agricultural Chemistry*—Recitations (optional), 2 hrs. *Quantitative Analysis*—continued six weeks, 20 hrs. *Organic Chemistry*—Experimental work

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during the remainder of the term, 20 hrs. *Geology*—Dana's; Recitations, 3 hrs. *Zoology*—Lectures, 2 hrs. *French*—3 hrs.

SECOND TERM:—*Theoretical Chemistry*—continued, 2 hrs. *Zoology*—continued 2 hrs. *Agricultural Chemistry*—(optional), 2 hrs. *Analytical Chemistry*—Analysis of Minerals and Technical Products, 20 hrs. *Assaying*—(optional). *Metallurgy*—Lectures (optional). *Geology*—Dana's, 3 hrs. *Mineralogy*—(optional). *French*—3 hrs., during Winter half-term.

The Laboratory Practice of the second term of the Senior year may be devoted to such special branches of Analytical or Organic Chemistry as the student may desire, or to original investigations in connection with theses.

(*b.*) IN CIVIL ENGINEERING:

JUNIOR YEAR.

FIRST TERM:—*Mathematics*—Analytical Geometry of Three Dimensions; Elements of the Theory of Functions; Differential Calculus, with applications to Geometry and Analysis; solution of Numerical Equations; 6 hrs. *Surveying*—Field Work, 16 hrs. till November. *Drawing*—Descriptive Geometry, 6 hrs. from November. *German*—3 hrs. *French*—3 hrs.

SECOND TERM:—*Mathematics*—Integral Calculus with applications to Geometry; Rational Mechanics; 6 hrs. *Drawing*—Descriptive Geometry, concluded; Topographical; Practice in working drawings; 6 hrs. *Surveying*—Topographical and Railroad curves, 16 hrs. *German*—3 hrs. *French*—3 hrs.

SENIOR YEAR.

FIRST TERM:—*Field Engineering*—Location of line of Railroad, setting out slope-stakes, calculation of earthwork; Lectures on economic location; Office work; Henck's Field Book; 20 hrs. till November. *Civil Engineering*—Mechanics applied to Engineering; Resistance of Materials; Bridges and Roofs; Stone cutting with Graphical Problems; 8 hrs. *Geology*—Dana's, 3 hrs. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy, 8 hrs. *French*—3 hrs.

SECOND TERM:—*Civil Engineering*—Bridges and Roofs; Building Materials; Stability of Arches and Walls; Foundations; 6 hrs. *Dynamics*—Principles of Mechanism; Thermodynamics; Steam Engine; 6 hrs. *Hydraulics*—Hydraulics and Hydraulic Motors, 3 hrs. *Drawing*—Designing; Practical Problems; Specifications and Estimates; 12 hrs. *Spherical Trigonometry and Astronomy*—Practical Astronomy, with field work, 6 hrs. *Geology*—3 hrs. *French*—3 hrs. during Winter half-term.

(*c.*) IN MECHANICAL ENGINEERING.

JUNIOR YEAR:

FIRST TERM—*Mathematics*—Annalytical Geometry of Three Dimensions; Elements of the Theory of Functions; Differential Calculus with applications to Geometry and Analysis; Solution of Numerical Equations; 6 hrs. *Surveying*—Theory and Practice, 3 hrs. until November 1st. *Principles of Mechanism*—

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Kinematics, 1 hr. *Shop Visiting*—Study of Machine Details and Tools; 3 hrs., beginning when Surveying ends. *Drawing*—Descriptive Geometry, 3 hrs. *German*—3 hrs. *French*—3 hrs.

SECOND TERM:—*Mathematics*—Integral Calculus with applications to Geometry; Rational Mechanics; 6 hrs. *Principles of Mechanism*—Applied Kinematics; Forms of Teeth of Wheels; Cams; Parallel Motions; Transmission of Power by Belts and Gearing, etc.; 1 hr. until Spring recess, then 2 hrs. *Shop Visiting*—continued, 3 hrs. until Spring recess. *Study of the Steam Engine*—2 hrs. after Spring recess. *Drawing*—Perspective and Shadows; Machine Elements; 3 hrs. *German*—3 hrs. *French*—3 hrs.

SENIOR YEAR:

FIRST TERM:—*Applied Mechanics*—Friction; Moment of Inertia: Centrifugal Force; Elasticity and Strength of Materials; Theory of Flexure and Torsion; Strains in Structures; Construction of Roofs and Bridges; Equilibrium and Pressure of Fluids; Theory of Flotation; Flows of Fluids in Pipes and Channels; Resistance of Ships; 9 hrs. *Machine Designing*—Practical Exercises in Designing Machine Details and Simple Machines, 12 hrs. *Study of the Steam Engine*—continued, 2 hrs. *Electricity*—(optional)—Laboratory work, 3 hrs. *Visits of Inspection*—Examination of Machinery in operation; Reports of Visits. *French*—3 hrs.

SECOND TERM:—*Applied Mechanics*—continued; Hydrodynamics; Theory of Water-Wheels and Turbines; 6 hrs. *Therymodynamics*—3 hrs. *Study of the Steam Boiler*—2 hrs. *Electricity*—(optional)—Laboratory work, 3 hrs.; Lectures, 2 hrs. *Machine Drawing*—continued; advanced exercises in Preparing Designs and Working Drawings for Machinery; Estimates and Weight and Cost of Machinery; 12 hrs. *French*—3 hrs. during Winter half-term. *Thesis. Visits of Inspection and Reports.*

(d.) IN AGRICULTURE:

JUNIOR YEAR:

The course is identical with that in Chemistry, except that in the second term lectures in Crystallography and Descriptive Mineralogy are omitted, and in the Spring half-term Botany is substituted for Determinative Mineralogy.

SENIOR YEAR:

FIRST TERM:—*Agriculture*—Recitations, 2 hrs.; *Agricultural Chemistry*—Recitations, 2 hrs. *Geology*—Recitations, 3 hrs. *Zoology*—Lectures, 2 hrs. *Meterology*—Lectures, 2 hrs. *Botany*—Laboratory Practice, 5 hrs. *French*—Recitations, 3 hrs.

SECOND TERM:—*Agriculture*—Recitations or Lectures, 2 hrs. *Agricultural Chemistry*—Recitations, 2 hrs. *Physiology*—Recitations or Lectures, 2 hrs. *Geology*—Recitations, 3 hrs. *Zoology*—continued, 2 hrs. *Heredity and Stock-Breeding*—Lectures, 2 hrs. during Winter half-term. *Sanitary Science and Public Health*—Lectures, 2 hrs. during Spring half-term. *French*—3 hrs. during Winter half-term.

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(e.) IN NATURAL HISTORY.

Either Mineralogy, Zoology, or Botany, may be made the principal laboratory study, some attention in each case being directed to the other branches of Natural History.

JUNIOR YEAR:

FIRST TERM:—*Organic Chemistry*—Lectures and Recitations. *Qualitative Analysis*—Fresenius's; Laboratory Practice; Recitations. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy, 4 hrs. *Botany*—Gray's Manual, 3 hrs.; Laboratory Practice, 3 hrs. *German*—3 hrs. *French*—3 hrs.

SECOND TERM:—*Zoology*—Laboratory Practice, 6 to 12 hrs.; Recitations; Excursions (land and marine). *Botany*—Lectures; Laboratory Practice in the identification of Phaenogamous Plants, 2 hrs. *Physiology*—Huxley's. *Embryology*—Lectures. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy, 4 hrs. Lectures in Crystallography and Descriptive Mineralogy, 2 hrs. *Physical Geography*—4 hrs. during Winter half-term. *German*—3 hrs. *French*—3 hrs.

SENIOR YEAR:

FIRST TERM:—*Geology*—Dana's. 3 hrs.; Excursions. *Zoology*—Laboratory Practice, 8 to 12 hrs.; Lectures, 2 hrs.; Recitations, 2 hrs.; Excursions. *Botany*—Laboratory Practice in the Preparation and Examination of Microscopical Specimens, illustrative of Stem-structure and of the Anatomy of the higher Cryptogamous Plants, 5 hrs.; Excursions. *Mineralogy*—Lectures, 2 hrs. *French*—3 hours.

SECOND TERM:—*Geology*—Dana's 3 hrs. *Anatomy of Vertebrates*—Huxley's, 2 hrs. *Zoology*—Laboratory Practice, 8 to 12 hrs.; Recitations, 2 hrs.; Lectures, 2 hrs. *Botany*—Herbarium Studies, especially in the Cryptogamous Orders; Botanical Literature; Essays in Descriptive Botany. *Sanitary Science, Laws of Heredity, and Principles of Breeding*—Lectures. *French*—3 hrs. during the Winter half-term.

Besides the regular course of recitations and lectures on structural and systematic Zoology and Botany, and on special subjects, students are taught in the laboratories to prepare, arrange, and identify collections, to make dissections, to pursue investigations, and when sufficiently advanced, to describe genera and species in the language of science. For these purposes, large collections in Zoology belonging to the University are available, as are also the private botanical collections of Professor Eaton.

(f.) IN BIOLOGY PREPARATORY TO MEDICAL STUDIES.

JUNIOR YEAR:

FIRST TERM:—*Organic Chemistry*—Lectures and Recitations, 2 hrs. *Qualitative Analysis*—Fresenius's; Laboratory Practice, 20 hrs; Recitations, 2 hrs. *Mineralogy*—Blowpipe Analysis and Determinative Mineralogy, 4 hrs. *German*—3 hrs. *French*—3 hrs.

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SECOND TERM:—*Comparative Anatomy and Histology* — Laboratory Practice, 18 hrs.; Lectures and Recitations, 1 hr. *Physiology*—Huxley's; Recitations, 2 hrs. *Embryology*—8 Lectures during the term. *Organic Chemistry*—continued, 2 hrs. *Mineralogy*—continued through Winter half-term, 4 hrs. *Botany*—Lectures; Laboratory Practice in the identification of Phaenogamous plants, 5 hrs. during Spring half-term. Excursions. *French*—3 hrs. *German*—3 hrs.

SENIOR YEAR:

FIRST TERM:—*Physiological Chemistry*—Recitations and Lectures, 3 hrs.; Laboratory Practice, 13 hrs. *Organic and Theoretical Chemistry*—Lectures and Recitations, 2 hrs. *Zoology*—Lectures, 2 hrs. *Botany*—Laboratory Practice in the Preparation and Examination of Microscopical Specimens, illustrative of Stem-structure, and of the Anatomy of the higher Cryptogamous Plants, 5 hrs. *Geology*—Dana's, 3 hrs. *French*—3 hrs.

SECOND TERM:—*Physiological Chemistry and Experimental Toxicology*—Illustrative Lectures, Recitations and Laboratory Practice, 27 hrs. *Geology*—Dana's, 3 hrs. *Zoology*—continued, 2 hrs. *Sanitary Science*—Lectures, 2 hrs. during Spring half-term. *Laws of Heredity and Principles of Breeding*—Lectures, 2 hrs. during Winter half-term. *French*—3 hrs. during Winter half-term.

(g.) IN STUDIES PREPARATORY TO MINING AND METALLURGY.

Young men desiring to become Mining Engineers can pursue the regular Course in Civil or Mechanical Engineering, and at its close can spend a fourth year in the study of Metallurgical Chemistry, Mineralogy, etc.

(h.) IN THE SELECT STUDIES PREPARATORY TO OTHER HIGHER STUDIES.

JUNIOR YEAR:

FIRST TERM:—*Mineralogy*—Blowpipe Analysis and Determinative Mineralogy, 8 hrs. *Astronomy*—Recitations, 4 hrs. *English*—Early English, 2 hrs. *History*—Green's Short History of the English People, 2 hrs. *French*—3 hrs. *German*—3 hrs.

SECOND TERM:—*Mineralogy*—Lectures; Laboratory work, 8 hrs. during Winter half-term. *Botany*—Lectures; Laboratory Practice in the identification of Phaenogamous Plants, 2 hrs. during Spring half term. *Physical Geography*—4 hrs. during Winter half-term; Recitations from Guyot and Lectures. *English*—Chaucer, Bacon, Shakspere, 2 hrs. during Winter half-term, 3 hrs. during Spring half-term. *History*—Green's History, continued, 2 hrs. during Winter half-term, 4 hrs. during Spring half-term. *German*—3 hrs. *French*—3 hrs.

SENIOR YEAR:

FIRST TERM:—*Geology*—Recitations, 3 hrs; Excursions. *Zoology*—Lectures, 2 hrs. *English*—Shakspere, 2 hrs. *Meteorology*—Lectures, 2 hrs. *Constitutional Law*—4 hrs. *French*—3 hrs.

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SECOND TERM:—*Geology*—continued, 3 hrs. *Zoology*—continued, 2 hrs. during Winter half-term. *Meteorology*—Lectures, 2 hrs. during Winter half-term *Sanitary Science*—Lectures during Winter half-term. *Political Economy*—Recitations, Exercises and Lectures, 4 hrs. *English*—Shakspere, Milton, Dryden, Pope, Gray, and later authors, 3 hrs. *French*—3 hrs. during Winter half-term.

Exercises in English Composition are required during the entire course from all the students. The preparation of graduating theses is among the duties of the Senior year.

Lectures and instruction in Military Science are annually given to the Senior class by the Professor of Military Science and Tactics.

The following account of the various subjects specified in the above scheme will explain the character and aim of the instruction.

ELEMENTARY CHEMISTRY—The exercises in Elementary Chemistry consist in recitations from a text-book, and experiments by the students in the laboratory to illustrate statements in the book. The object of the laboratory work is to facilitate the study of the subject, and to train the students in manipulation and in the observation of chemical phenomena. Notes are required and students are questioned on the experiments. As a class is divided as to scholarship at the end of the fall term, opportunity is given to those who are most proficient to make rapid progress.

ANALYTICAL CHEMISTRY—*Qualitative and Quantitative*—This study is intended to serve two purposes. Analytical Chemistry is used by the advanced student as a means of investigation in scientific or technical researches. The beginner, however, derives from its study advantages of another kind. The knowledge of the properties of chemical compounds, the familiarity with chemical reactions gained by experience in the laboratory, and the development of the reasoning faculties by the application of this knowledge in analytical processes, enable the student to generalize and classify chemical phenomena and aid him to understand the more abstract theories of chemical philosophy. The method of instruction adopted is conformed to this view of the uses of the study. Text-books are used and recitations are required, but the more important part of both study and instruction is performed in the laboratory. In order to solve the problems which are there constantly presented, the student, aided by books and instructors, must learn both principles and their applications. The student, throughout his course in Analytical Chemistry, spends four consecutive hours in laboratory work during five days of the week. The laboratory, however, is kept open seven hours daily for the benefit of graduate students and others who desire to devote more time to this study.

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Qualitative Analysis forms a part of the courses in Chemistry, Biology, Agriculture, and Natural History. Quantitative Analysis is one of the more important studies of the Senior year in the Chemical course. It is also included to some extent in the Agricultural Course.

ORGANIC CHEMISTRY is taught by informal lectures and experimental illustrations as well as by text-book drill, a lesson from Bernthsen's Organic Chemistry being given out for each instruction-hour. The class has two exercises weekly throughout the year. The course is adapted to give a fairly complete outline of the subject and some familiarity with the more important bodies and classes of bodies.

In addition to this, the Senior students in the Chemical Course are required to spend 20 hours per week during the latter half of the first term in experimental work in Organic Chemistry. This is intended to supplement the preceding course, and at the same time to serve as a preliminary training for such students as desire to make a special study of Organic Chemistry.

Opportunity is also afforded for the carrying on of original investigations in this subject, either in connection with theses or as a part of the regular work in the case of advanced students.

PHYSIOLOGICAL CHEMISTRY and EXPERIMENTAL TOXICOLOGY—Physical Chemistry is taught by laboratory exercises, illustrative lectures and recitations. Each student is provided with a suitable working place in the laboratory, well equipped with all needed apparatus and material. The regular course of work, designed especially for Senior students in the Biological Course, extends throughout one year and embraces a thorough study of the chemical composition of the various tissues and fluids of the body, together with a study of the chemical and physiological processes of respiration, digestion, secretion, excretion, and nutrition in general.

Beginning with a study of the albuminous bodies, the experimental work extends through the epithelial, connective, contractile, and nerve tissues. Proceeding then to a digestion, the various digestive fluids are studied, artificial digestions are made, and the several products of digestive action isolated and studied. The blood and urine are next considered, and students are taught to make both qualitative and quantitative analysis of the latter and to identify abnormal constituents. A portion of one term is also devoted to a study of the chemical reactions of the more important mineral and organic poisons, and their physiological action is determined experimentally. Students are also taught how to separate poisons from organic tissues and fluids, and to identify them, both by chemical physiological reaction. During the latter half of the second term, Senior year, opportunity is afforded for the carrying on of original investigations on some selected subject in either physiological chemistry or toxicology, in connection with the preparation of graduating theses. The course of work is particularly recommended to students intending to enter upon a course of medical studies.

COMPARATIVE ANATOMY AND ELEMENTARY PHYSIOLOGY—The object sought in the instruction in Anatomy and Physiology, as taught during Junior year, is the manual and mental training of the student in the methods of investigation by which the facts and principles of these sciences have been established, and at the

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same time to give him a sufficient knowledge of their elements to enable him to pursue with profit the special studies of the Biological Course as a preparation for medical studies. With this end in view, five forenoons each week are given to laboratory work in Anatomy and Histology. The student, under the immediate supervision of the instructor, dissects specimens of a number of different animals, and is required to make careful sketches and records of his work; he also examines the different animal tissues with the microscope, makes microscopical preparations, and is taught the methods of anatomical and histological investigation. This work is reviewed each week by means of text-book and recitations, or by lecture and examination. The elements of Human Physiology are taught by text-book, recitations, and demonstrations. The physiology of digestion and nutrition is taught during the Senior year in connection with Physiological Chemistry. During the last part of the term there is a short course of lectures on Embryology with special reference to Human Morphology.

GEOLOGY—The course in Geology includes recitations and oral instructions, extending through the entire year on alternate mornings. During the first half-year, the recitations are attended by the entire Senior Class, except those in the course in Mechanical Engineering. This part of the course includes Physical, Lithological and Dynamical Geology. These subjects are illustrated by diagrams and specimens. During the first term, each student is required to make a collection containing a specified number of the most important rocks and minerals, and to pass a thorough examination upon them at the end of the term; the object is to compel every student to become personally familiar with the appearance, as well as with the composition and other characters, of the rocks and minerals that are of the most importance in Geology, as well as in the arts.

The last half of the year is devoted to Historical Geology and Palaeontology. This part of the course is pursued by all the Seniors except those in the courses in Mechanical and Civil Engineering. Suitable collections of fossils are used to illustrate the object.

Opportunities are afforded for optional geological excursions during the warmer months.

MINERALOGY—The instruction in Mineralogy is carried on by means of practical work in a laboratory especially fitted up for the purpose, and is intended to familiarize the student with the common minerals, attention being devoted especially to those which are of economic, geological, or scientific importance. To understand better the chemistry of the subject, the student is first made familiar with the simple chemical and blowpipe reactions useful in testing minerals, and applies this knowledge later to the determination of unknown species. The students have access to a labeled collection where they can study the properties of the minerals and make comparisons, and also to extensive unlabeled collections, arranged especially to give them practice and facility in the correct identification of minerals. In addition to the laboratory work, instruction is given in Crystallography, illustrated by a collection of models and natural crystals. The lectures in Descriptive Mineralogy to the more advanced students are illustrated by means of the extensive private collection of Professor Brush. The laboratory is provided with apparatus for the thorough chemical and physical investigation of

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minerals, and with an extensive library to which students have access. The laboratory is open seven hours each day to accommodate any who desire to devote more time and attention to the subject than is laid out in any of the prescribed courses.

ZOOLOGY—The instruction in Zoology includes a course of lectures on Systematic Zoology, Morphology, and Embryology, which are attended by all the Seniors except those in the courses in Mechanical and Civil Engineering. These lectures are generally given twice a week, and continue during about half the year. The students are required to keep careful notes of the lectures.

Students in the Natural History Course are also required to pursue a course of laboratory instruction during the second term of the Junior and all of the Senior year. This generally occupies from two to four hours a day on four days of each week. It includes dissections of various classes and orders of animals, with microscopic studies of the finer structures and of minute animal forms, as well as work in systematic Zoology.

Special courses of recitations or lectures on particular subjects are also given when desirable.

BOTANY—The scheme of instruction provides for three successive courses of study, as either ending the study for the ordinary student, or introducing it for one who desires to become a professional botanist.

The first or elementary course, which is required of all the Freshmen, is designed to teach the nature of the visible organs of flowering plants, tracing the life-history of vegetation from seed, through stem and root, leaves, branches, buds, blossoms, and fruit, to seed again. The method consists mainly in the use of some easy text-book, like Gray's Lessons, with whatever illustrations and explanations may be needed to secure the student's attention. The second course, coming the next year, is restricted to the sections in Biology, Natural History, Agriculture, and Selected studies, and is intended to enable the student to recognise the chief natural orders of native plants, with the ability to identify the common species. The class meets two or three times a week in spring and summer, and is practiced in identifying plants, using Gray's Manual as a standard, and employing the ordinary simple dissecting microscope. At this point the instruction for the Select Course ceases; in the next fall term the work for the courses in Biology, Natural History, and Agriculture is entirely practical, books being used only for reference. Students begin with cutting thin sections of some common woody and herbaceous stems, and are shown how to prepare such sections for examination and for permanent preservation as microscopic objects. After acquiring some facility in microscopic manipulation, various parts of flowering plants are brought in for dissection and examination, and towards the close of the term some attention is given to Ferns, Mosses, and Algae. This finishes the course for ordinary students; for those who may desire to prosecute the science professionally, the work is arranged to suit individual requirements, whether it be in the direction of Histology, or of Systematic Botany as applied to flowering plants, or to Ferns, Mosses, Hepatics, or Algae.

MATHEMATICS—The Mathematical studies of the Freshman year are pursued by all members of the class; those of the Junior year by students in the course of

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Engineering and properly qualified Special Students who may choose them. During the latter year, in connection with the instruction briefly indicated in the scheme above [p. 88], a course of familiar lectures is given to supplement the ordinary class-room exercise.

PHYSICS—The object of the experimental lectures is not only to elucidate the subjects treated in the text-book employed, but also to extend the treatment of such subjects, and to introduce others where thought desirable. A considerable portion of the work of the year is the preparation for recitation on matter thus presented.

At the end of the fall term, the Freshman class is re-divided into three sections, according to capacity shown in the subjects of Chemistry and Physics. After this, although the experimental lectures are attended as before by the class as a whole, the higher divisions are able to pursue the studies more thoroughly.

The facilities of the Physical Laboratory are extended to such graduate students and Seniors as may desire them.

Course in Advanced Physics—A course of two lectures per week, beginning in January, is supplemented by laboratory work. The earlier portion of the time is devoted to the theory of observation and the method of least squares. The course is optional to all who have a command of the Calculus.

MILITARY SCIENCE AND TACTICS—Instruction in this course is obligatory upon the whole Senior class in all departments. To secure familiarity with definitions and fundamental principles, a concise text-book is used for recitations and reference. The work is carried on chiefly by lectures, upon which satisfactory notes must be submitted. Such topics as the following are discussed: Military Economy; the American military problem; organization and re-organization; modern war on field and map; statistics and logistics; the combined use of "the three arms"; strategy and campaigning; orders of battle and grand tactics; special operations of war and field service; minor tactics and the art of war; use of cavalry in campaign and battle; use of artillery and the Franco-Prussian war; use of infantry and the Turko-Russian war; and finally a summary of "the Eastern Question." The course will terminate with an examination, and a special military certificate is awarded, by the Regular Army officer in charge of the department, to such students as attain a sufficient degree of proficiency, and give evidence of military aptitude. In connection with this course a brief original paper is required.

CIVIL ENGINEERING—The object of this course is to give a thorough preparation, first of all, in the principles of the various sciences involved, and afterwards, as extensive practice in the application of these principles as the time at disposal, the ability of the students, and the facilities and plant permit.

Under the first head are included such subjects as Mathematics, Physics, Mechanics, Thermodynamics, Astronomy, Geology, Mineralogy, Chemistry, and Botany; and under the second head, Drawing, Surveying, Strength and Properties of Materials, and Design and Construction of various kinds, such as Bridges, Roofs, Foundations, Arches, Retaining Walls, Dams, Water Works, Railroads, Improvements of Rivers and Harbors, Sewerage and Drainage, Water Motors, etc.

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The first division includes Civil Engineering as a Science, the other, Civil Engineering as an Art. The ground covered by the first is definite, and the instruction is made as thorough as possible. The ground covered by the second is of almost indefinite extent. Here, by a careful selection of practical examples, such as occur in engineering practice, the application of principles is illustrated, and together with the analytical or algebraic methods, the student is also instructed in practical graphic solutions, wherever such solutions present a special value. Much time is devoted to geodetic operations and to surveying in the field. Instruction is given in the practical operations connected with the reconnaissance, location, and surveys of roads, canals, and railroads, such as setting out, cross-sectioning, setting grade stakes, calculation of earthwork, etc. Thorough instruction is given in drawing and design, the construction of working drawings, and principles of designing as applied to bridges, roofs, etc.

The instruction is by means of practical exercises, lectures, and recitations, so combined as to develop as far as possible the mental powers of the students. Visits of inspection are made at suitable intervals to private and public works of engineering interest.

The entire course requires five years, three years of undergraduate and two of graduate instruction; and a Thesis of merit upon some approved subject, accompanied by designs and estimates, is required upon the completion of the course, as also at the end of the first three years. Examinations are also held at the end of every term and year.

In what follows, such details are given as may be of interest to those who contemplate taking the course.

Mathmatics—6 hours weekly, Junior year, both terms. See Synopsis of Course.

French and German—Students in this course take in the Junior year the regular studies of the Junior class in both German and French, 3 hours each. In the Senior year, French is continued, 3 hours to the end of the Winter half-term.

Drawing and Descriptive Geometry—Drawing is begun at once in the first term of the Freshman year, under the charge of the Professor of Drawing in the Art School, and includes practice in free hand drawing. In the second term, under the Instructor in Instrumental Drawing, the students take isometric drawing with application to drawing from models and structures by measurement, shading, tuning, conventional use of colors, principles of orthographic projections, and practice in making simple working drawings, 4 hours both terms.

The Drawing of Junior year, 3 hours both terms, includes Descriptive Geometry, the drawing of structures from measurement, and elements of design for simple structures. The instruction is by recitations, lectures, practical exercises and models, and is under the charge of the Instructor of Instrumental Drawing and the Professor and Instructor of Civil Engineering. Included in the work of this year is also the mapping of surveying field notes.

In the Senior year, the drawing consists of the mapping of the surveys of that year, and the designing of structures and finished drawings, designs and estimates, under the charge of the Professor and Instructor of Civil Engineering, 6 hours both terms.

Surveying and Field Engineering—The instruction in the field occupies about 20 hours for six or more weeks in both terms of Junior and Senior year. The exer-

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cises at these times are so arranged as to secure as much consecutive time as possible in the field. The work of the Junior year includes the use and adjustment of instruments; practice surveys; recitations and lectures upon surveying operations and methods of keeping field notes. Levels are run, surveys made, plotted and checked; blue print copies of drawings made, the use of compass, level and transit acquired. In the second term of Junior year, land and topographical surveys are made and railroad curves run.

In the first term of Senior year, a line of railroad is located and set out from a contour map previously obtained, grades and curves established and set out, and computations made. The theory of economic location is taught by lectures and recitations in connection with the field work. The work is arranged so that each student has sufficient practice in all the various operations. The text-books used are Gillespie and Johnson's works, Henck's Field Book, Gore's Elements of Geodsey, and Merriman's Theory of Least Squares. The course is under the charge of the Professor and Instructor of Civil Engineering, aided by several assistants.

Mechanics of Engineering—Senior year, 6 to 8 hours, both terms. The text-books of Weisbach, 1st and 2d volumes, are used in connection with lectures and solutions of practical problems in illustration of the various topics. The course includes thorough instruction in the strength of materials, the stability of foundations, retaining walls, dams and embankments, and masonry arches, by lectures and graphic methods. Questions of hydraulics, water supply, and measurement of discharge, receive attention, and the theory and construction of water motors. A course in Thermodynamics with application to air and steam engine is also included.

Construction and Design—Senior year, 6 hours both terms. A thorough course is given in the determination of stresses and the detailed design of roofs, bridges, etc., with working drawings, specifications, and estimates. Visits of inspection are made, and recitations and lectures held in connection with the work in the drawing room.

Astronomy—This course occupies 6 hours during the second term of Senior year, and includes practical work and the use of the sextant and transit in determining time, latitude and azimuth.

Geology—This course occupies 3 hours up to the middle of the second term of Senior year.

Mineralogy—This course, under the Professor of Mineralogy, occupies three hours up to the middle of the second term in Senior year.

A course of lectures on the theory of electricity and its application by the Professor of Physics, is open to students in this department, and can be taken as a part of the preparation for a graduate course in the higher branches of electrical science.

MILITARY ENGINEERING—The object aimed at is to disseminate military information, and to awaken interest in the application of the arts of peace to those of possible war. In connection with the courses of Civil Engineering and Military Science, lectures will be given upon such topics as: systems of fortifications; sea-coast defenses; hasty entrenchments; passage of rivers and military bridges; military reconnaissance, and instruments; battlefield telemetry and methods;

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sea-coast range-finding, and ship-tracking devices; gunpowder and ballistic machines; high explosives and demolitions; gun metals, modern ordnance and gunnery; armor plates, turrets, projectiles, and fuses; torpedoes, submarine mines, military electric installation, and countermining.

MECHANICAL ENGINEERING—The objects aimed at in the plan of instruction in this course are, to give to the student a thorough training in elementary and advanced Mathematics and Physics, and their application to the Science of Construction; to make him familiar with the general principles of Engineering and with the practical details of mechanical construction through which these principles are made useful; and to enable him ultimately in beginning the work of his profession to bring to bear upon it a well balanced store of theoretical and practical knowledge, and a mind trained in correct habits of thought and work.

The complete course covers five years, three of which are spent in undergraduate study, and two in a graduate course; a portion of which may be spent in actual practical work. The subjects and methods of instruction in the undergraduate course are as follows:—

Mathematics—See synopsis, page 89

French and German—Students take in the Junior year the regular studies of the Junior class in both French and German. In the Senior year, French is continued to the end of the winter half-term.

Surveying—A short course in Surveying comprises lectures on methods of surveying and the construction and use of instruments, also practice of field work in the use of the level and transit, city surveying, establishing grades, and laying out buildings.

Shop Visiting divides the time equally with Drawing in the Junior year until the spring recess. The student, accompanied by the instructor, is employed in studying machinery in use and in process of construction in different machine shops in the city. He is required to make satisfactory, carefully dimensioned sketches, from measurements taken by himself, of the complete machines and their parts, and to describe the tools and mechanical operations used in producing the simpler pieces.

Drawing—Descriptive Geometry is taught in the drawing room by lectures and recitations, and by exercise at the drawing board, where the problems are solved graphically by the student. Instruction in drawing Machine Elements is given in the Junior year. Models and cartoons showing examples of approved practice are used by the instructor, who also gives personal attention to each student's work at the board as it progresses.

Principles of Mechanism—This is a course in theoretical and applied Kinematics. Instruction is by text books and lectures illustrated by diagrams and models, an extensive collection of which belongs to the School and is accessible to the student.

Steam Engine—Recitations and lectures in this subject begin in the Junior year, after the spring recess. They relate to the structural details of engines and to the mechanical principles involved in their working. The subject is continued in the first term of Senior year, when particular attention is directed to various kinds of valve gear, the governor, the fly-wheel, balancing, and the effect of the weight of the reciprocating parts. In the second term of Senior year, the study of *Steam Boilers* takes the place of that of Engines.

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Indicator Practice—In the Senior year, the student is afforded opportunities to apply the indicator to various engines in operation, and has practice in reading indicator cards and measuring them by the planimeter. He is taught to detect such defects in the engine as are shown by the cards.

Applied Mechanics—In this course lectures, recitations, and exercises in the solution of practical problems, relate to the topics specified under this head in scheme on page 89.

Thermodynamics—Recitations and lectures on the mechanical theory of heat and its application to hot-air engines, gas engines, and the steam engine.

Machine Design—The course in this subject consists chiefly in practical exercises at the drawing board, and partly in lectures on the functions of machines and the mechanical principles which are applied in determining the proportions of machinery. The student, under the guidance of an experienced instructor, is employed in making complete working drawings of machines, many examples of which are in the drawing rooms and the basements of the school. He does not copy the examples, but is required to change the dimensions and in many cases to alter the design, and is ultimately taught to make partly new designs of important machinery, such as cranes, yacht engines, machine tools, boilers, etc. The discipline the student receives is such as he would obtain in the drawing office of an engineering establishment, while he is also carefully instructed in the theory of the subjects he deals with, and in the practical bearing of all his work.

In the Senior year, several excursions are made by the class, accompanied by one or more instructors, to neighboring manufacturing and engineering centers where large manufactories, pumping works, ocean steamers, etc., are visited Full notes must be taken, and a satisfactory written report upon the machinery examined is required of the student.

Thesis—Before graduating, the student must present a satisfactory thesis on some subject approved by the professor in charge of the department of Mechanical Engineering.

A course of lectures on the theory of Electricity and its applications is open to students in this department, and these lectures can be taken as a part of the preparation for a graduate course in the higher branches of electrical science.

ASTRONOMY—Students in the Select Course receive instruction in Astronomy during Junior year, first term, four hours per week.

Students of Civil Engineering during the second term of their Senior year have six recitations per week, and also practical experience in the determinations of time, azimuth, latitude, longitude, etc.

ENGLISH—The course is designed to give the student acquaintance with the great representative writers of the various epochs. A history of the language is one of the studies of the Freshman year; and after that year the study of the language is made entirely subordinate to that of the literature. During first term of Junior year, however, extracts from Early English authors are read, and Early English Grammar studied, so as to familiarize the student with the inflections then in use and the distinctions between the leading dialects. It is the aim of this term's work to give such knowledge of forms, and to some extent of words, that the student will be able to read at sight any Early English author whose writings do not involve special difficulties of language or vocabulary.

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With the second term, the regular study of English literature proper begins with Chaucer; and for the rest of the course till the end of Senior year the following authors are read: Bacon, Shakespeare, Milton, Dryden, Pope, Gray, Goldsmith, and later writers. Those mentioned in the list are always studied, but other authors not named are also taken up, the course varying somewhat in different years. In all cases, complete works of a writer are studied, not extracts: as, for instance, several of Chaucer's Tales, and several of the plays of Shakspere. The authors are taken up in chronological order, and the literary history of the time is likewise carried on in connection with the great representative writers of each period.

GERMAN—The aim in this department is to give such a knowledge of facts and principles as shall qualify the student as rapidly as possible to use the language for such various purposes as his special needs may require, and particularly to facilitate the use of German treatises in his later special studies. To accomplish this, the course consists of the combination of the study of systematic German grammar with a complimentary and progressive course of oral translation from English into German, the latter being designed for the double purpose of increasing the command of grammatical principles, and through the establishment of a habit of ready and accurate expression, of laying the foundation for future colloquial use of the language. In connection with the foregoing, it is attempted to introduce the student to as many different styles and as many forms of composition as the time allows. For this purpose the reading matter is in general selected from readers and collections prepared for the use of schools in Germany, and characterized by the number and variety of their extracts, thus enabling the instructor to select pieces that illustrate one another and to avoid similar lines of reading with successive classes. Constant attention is paid during a portion of the course to English affinities, to analogies in the formation of English and German abstract terms, to the commoner rhetorical resemblances and differences to the details of arrangement in German sentences, and the development of secondary from primary significations of words.

In view of the shortness of the course there is no attempt to secure any considerable acquaintance with German literature. A body of representative pieces of lyric poetry, however, is made the basis of careful literary study, with special attention to poetic diction and variety of metrical form. Memorising German poems is practiced to some extent as a class exercise, as also retranslation of dictated literal versions of simple pieces into German verse, in accordance with prescribed rhythm and sequence of rhyme.

Occasionally, when the proficiency of a class allows it, an advanced division is organized, which is thus enabled to read a much larger amount of matter and to pursue more critical methods. The attention of such a division is sometimes given for a few months to extracts treating of leading events in German history, with a collateral course of German historical poetry, the selections being made so as to be mutually illustrative. Historical poems not contained in the text-books are often furnished by dictation.

During the last few weeks of the course, there is an attempt to initiate the student into the art of rapid and intelligent, though uncritical reading, dispensing largely with dictionary and grammar and aiming to form independent habits of

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observation and induction. For this purpose recourse is had to entertaining novels.

In general, it is the endeavor, while aiming primarily and constantly at acquiring a working knowledge of contemporary German, to combine habitually scientific and empirical methods, to enforce correct notions as to the nature of language, to secure incidentally some of the most important disciplinary results of elementary linguistic study, and to give some conception, by suggestive questions and occasional statements, of the various special directions which a more extended and advanced course would necessarily take.

The time allotted to the subject is three hours a week during the Freshman and Junior years.

Regular text-books: Whitney's German Grammar, Whitney's German Dictionary; Ahn's Exercises, or Eysenbach's German Exercises.

FRENCH—To avoid repetition, it will suffice to state that much the same course is pursued in French as is above detailed for the German, and on like principles. The three weekly exercises extend through the entire Junior, and most of the Senior year, based on a systematic review of the essential elements. In the Junior year, a wide extent of reading is insisted on, beginning with the simpler novels, such as "Le Conscrit," "L'Ami Fritz," "La Petite Fadette," etc., through a scale of diversified vocabulary by which at last sight-reading of such matter as is more appropriate to the department may be profitably entertained. The practical or conversational course runs along parallel with the more systematic study of the language.

In the second year, the aim is to familiarize the student with practical terms and expressions of a scientific cast, rather than with the purely literary language. Hence practical works, such as books of travel and scientific treatises, have seemed best adapted to the general object in view.

HISTORY—The greater part of the work is carried on by means of recitations, Green's Short History of the English People being used as a text-book. The students are also required to look up special topics, and to give the results of their studies to the class: the books used for this purpose are drawn from a small historical library in the class-room. The location of places is enforced by the use of outline maps which the students are required to fill in. Particular attention is given to the history of institutions and to the constitutional and economic growth of the country.

POLITICAL ECONOMY—In the beginning of the course, an effort is made to familiarize the students with the fundamental principles of Economics, and more particularly to train them in economic reasoning. More difficult problems are then taken up and discussed, and special topics are assigned to the class for investigation. A small library, containing a number of copies of each of the principal authorities, has been provided, in order that the students may be able to familiarize themselves somewhat with the literature of the subject, without expense to themselves.

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TUITION CHARGES.

The charge for tuition for undergraduate students is $150 per year, payable $55 at the beginning of the first and second terms, and $40 at the middle of the second term. An additional charge of $5 a year is made to each student for the use of the College Reading Room and Gymnasium, which is payable at the beginning of the first term, making the total charge for that term $60. The student in the Chemical course has an additional charge of $70 per annum for chemicals and use of apparatus. He also supplies himself at his own expense with gas, flasks, crucibles, etc., the cost of which should not exceed $10 per term. A fee of $5 is charged members of the Freshman Class for chemicals and materials used in their laboratory practice, and the same fee is required from all (except Chemical students) who take practical exercises in Blowpipe Analysis and Determinative Mineralogy. A fee of $5 a term is also charged to students in the Zoological and Anatomical Laboratories, for materials and use of instruments.

For graduate students the charge for tuition is one hundred dollars per year.

CHURCH SITTINGS.

Free sittings for students in this department of Yale University are provided as follows: in the Center Church (Congregational); in the Trinity (Episcopal); and in the First Methodist Church.

Those who prefer to pay for a sitting for one year, more or less, in the churches above mentioned, or in any other church of any denomination, will be aided on application to the Secretary of the School.

Sittings in the Gallery of the College Chapel are free as heretofore to the students of this department.

DEGREES.

Students of this department, on the recommendation of the Governing Board, are admitted by the Corporation of Yale College to the following degrees. They are thus conferred:

1. Bachelor of Philosophy: on those who complete any of the three-years courses of study, passing all the examinations in a satisfactory manner, and presenting a graduation thesis.

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The fee for graduation as Bachelor of Philosophy, including the fee for Triennial Catalogues, Commencement Dinners, etc., is $10; unless the person taking the degree is also an academical graduate, when it is but $5.

2. CIVIL ENGINEER AND MECHANICAL ENGINEER: The requirements of this degree are stated on pages 47 and 48.

DOCTOR OF PHILOSOPHY: The requirements of this degree are stated on pages 45 and 46.

TERMS AND VACATIONS.

The next academic year begins Thursday, September 24, 1891.

For length of terms and vacations, see Calendar, p. 28.

ANNOUNCEMENT IN RESPECT TO STATE STUDENTS.

The scholarships established in this School in consequence of the bestowal upon it of the Congressional grants are designed to aid young men who are in need of pecuniary assistance in fitting themselves for agricultural and mechanical pursuits of life. All applicants must be citizens of Connecticut. In case there are more applicants than vacancies, candidates will be preferred who have lost a parent in the military or naval service of the United States, and next to these such as are most in need of pecuniary assistance; and the appointments will be distributed as far as practicable among the several counties in proportion to their population. The appointing Board for the current year, consisting of the Board of Visitors for the State and the Secretary of the School, will meet on June 23, 1891, and at or about the same time in the year 1892, due notice of which will be given by publication in every county in the State. All applications should be made previous to that time. Blank forms for application will be sent, when requested, by Professor GEORGE J. BRUSH, Secretary of the Appointing Board.

ANNIVERSARY.

The Anniversary of the School is held on Monday of the Commencement week of Yale University, when selections from the graduation theses are publicly read. The degrees are publicly conferred by the President and Fellows of Yale University on Commencement Day.

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APPENDIX.

ENTRANCE EXAMINATION PAPERS.

The following are the papers for 1890, upon which applicants for admission were examined at the June and September examinations.

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ARITHMETIC.

JUNE, 1890.

(1.) Find the greatest common divisor of 187, 442, and 969.

(2.) Divide and multiply 427 by 0.0023.

(3.) Find the sum and difference of $8\frac{1}{3}$ and $5\frac{3}{16}$.

(4.) If $300 is paid for the work of 20 men 6 days, what should be paid for the work of 8 men 3 days.

(5.) What is the bank discount and proceeds of a note for $890 payable in 90 days, discount 6%.

(6.) Extract the square root of 0.0125 to three places of decimals.

(7.) Reduce a pressure of 80 pounds on each square inch to kilograms per square meter.

ARITHMETIC.

SEPTEMBER, 1890.

(1.) Multiply and divide $3\frac{1}{16}$ by 8.028.

(2.) What would be the pressure on each square inch at the base of a column of water 10 feet high, the weight of a cubic foot of water being 62.5 lbs.

(3.) For what sum must a note be drawn, payable in 90 days, without interest, that the avails may equal $600, when the note is discounted at a bank at 6%.

(4.) Extract the square root of 3.002 to three places of decimals.

(5.) How many liters and how many cubic feet of water are contained in a cistern 4 meters in diameter and 3 meters deep.

(6.) If the velocity of a train is 40 miles per hour what is the velocity in feet per second.

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PLANE GEOMETRY.

JUNE, 1890.

[NOTE—State at the head of your paper what text-book you have studied on the subject and to what extent.]

1. Two straight lines which are parallel to a third straight line are parallel to each other.

2. Two sides of a triangle, and the angle opposite one of them, are given. Construct the triangle, giving all possible solutions.

3. The perimeter of the circumscribed equilateral triangle is double that of the similar inscribed triangle.

4. Similar triangles are as the squares on any two homologous lines.

5. The circumference is the limit of the perimeters of the circumscribed and inscribed similar regular polygons when the number of sides is indefinitely increased.

6. The area of a certain polygon is S square feet. Find the area of the similar polygon whose perimeter is in the ratio of m to n to that of the given polygon.

SOLID GEOMETRY.

JUNE, 1890.

[NOTE—State at the head of your paper what text-book you have studied on the subject and to what extent.]

1. Three parallel planes cut proportional segments from straight lines intersecting them.

2. A plane passed through two diagonally opposite edges of a parallelopiped divides it into two equivalent triangular prisms.

3. The sides of a right triangle are a and b. Compare the volumes of the solids of revolution generated about these sides as axes.

4. Define *polar* triangles. Between what limits must the sum of the angles of all spherical triangles lie? Give proof.

5. Find the volume of a sphere whose area in 16π.

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PLANE GEOMETRY.

SEPTEMBER, 1890.

[NOTE.—State at the head of your paper what text-book you have studied on the subject and to what extent.]

1. Define *locus*. Find the locus of all points equidistant from two parallel lines, proving result.

2. The common chord of two circles is perpendicular to, and is bisected by, the line joining their centres.

3. To divide a given line in extreme and mean ratio. What regular inscribed polygons may be constructed by means of this division? Prove your statement.

4. Two circles are tangent internally, the ratio of their radii being $\frac{2}{3}$. Compare their areas, and also the area left in the larger circle with each.

5. Of all polygons formed of given sides the maximum may be inscribed in a circle.

SOLID GEOMETRY.

SEPTEMBER, 1890.

[NOTE.—State at the head of your paper what text-book you have studied on the subject and to what extent.]

1. The intersections of two parallel planes by a third plane are parallel lines.

2. Two tetrahedrons having a trihedral angle equal, are as the products of the including edges.

3. In any spherical triangle, the greater angle is opposite the greater side, and conversely.

4. A certain spherical triangle is in area, $\frac{1}{8}$ that of its sphere. If the relation connecting the angles be $2A=3B=6C$, find A, B, and C.

ALGEBRA TO QUADRATICS.

JUNE, 1890.

[NOTE.—State at the head of your paper what text-book you have studied on the subject and to what extent.]

1. Resolve the following expressions into factors:

$$(a)\ x^3-2ax-2bx+4ab;\ (b)\ x^4-1;\ (c)\ x^5+1.$$

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2. Reduce $\frac{3x^3+2x-1}{x^3+x^2-x-1}$ to its lowest terms.

3. Solve the equation $3x-\frac{x-4}{4}-4=\frac{5x+14}{3}$.

4. Solve the simultaneous equations:

$$bx+dy=a+c \text{ and } \frac{x}{a}+\frac{y}{c}=\frac{b+d}{bd}.$$

5. Show that, if $\frac{a}{b}=\frac{c}{d}$, then $\frac{a-b}{a+b}=\frac{c-d}{c+d}$.

6. Expand $(a-bx)^4$ by the binomial formula.

7. Simplify the following expressions:

(*a*) $\sqrt[10]{4}$; (*b*) $(81)^{\frac{3}{4}}$; (*c*) $\sqrt{\frac{a^3b^4}{c^6d^2}}$; (*e*) $2\sqrt{8}+3\sqrt{288}$; (*f*) $\sqrt{2}\times\sqrt[3]{3}$.

ALGEBRA FROM QUADRATICS.

JUNE, 1890.

[NOTE.—State at the head of your paper what text-book you have studied on the subject and to what extent.]

1. Solve the equation $ax^2+a=(a^2+1)x$.

2. Determine all the roots of the equation,

$$x(x+a)\ (x^2-b^2)=0.$$

3. Solve the equation $2(x-4)=\sqrt{3x-2}$.

4. Given the simultaneous equations,

$$x^2+xy=15 \text{ and } xy-y^2=2;$$

to find all the values of x and y which satisfy them.

5. Given the amount of a given principal at compound interest for a given number of years, to find the rate per cent.

6. Expand $\frac{1+2x}{1-x-x^2}$ into a series by the method of indeterminate coefficients.

7. Find the limit of $\frac{(x^2-1)\ (x^2+2)}{x^4-3}$ when x becomes infinite.

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ALGEBRA TO QUADRATICS.

SEPTEMBER, 1890.

[NOTE.—State at the head of your paper what text-book you have studied on the subject and to what extent.]

1. Find the highest common factor of
$$2x^3+5x^2-12x \text{ and } 6x^2+x-15.$$

2. Solve the equation $\frac{x-2a}{x+3a} - \frac{13a^2-2x^2}{x^2-9a^2} = 3.$

3. Solve the simultaneous equations,
$$3ax-2by=c,\ a^2x+b^2y=5bc.$$

4. What is greater, $\frac{a+x}{a}$ or $\frac{4x}{a+x}$? Prove your answer.

5. Expand $(ax-2b)^5$ by the binominal formula.

6. Simplify the following expressions:

(a) $\frac{a+x}{\sqrt{a+a}}$; (b) $\sqrt[3]{64a^6b^3}$; (c) $\frac{\sqrt{50a^6b^4}}{\sqrt{2a^2b^2}}$; (d) $(2\sqrt{a^3})^2$.

7. Reduce $\frac{2}{\sqrt{5}+\sqrt{2}}$ to an equivalent fraction with a rational denominator.

ALGEBRA FROM QUADRATICS.

SEPTEMBER, 1890.

[NOTE.—State at the head of your paper what text-book you have studied on the subject and to what extent.]

1. Solve the equation $4x^2-5x=21$.

2. Ascertain for what value of a the roots of the equation
$$ax^2-4x+2=0 \text{ will be equal.}$$

3. Determine all the roots of the equation,
$$(x-1)\ (x+2)\ (x^2-6x+9)=0.$$

4. Solve the simultaneous equations,
$$2x^2+xy=15 \text{ and } 2y^2-xy=30.$$

5. Determine (1) the number of different arrangements of m different things taken all together and (2) the number of arrangements of the m things taken in sets of n.

6. Insert three geometrical means between 2 and 162.

7. Expand $\frac{a+bx}{a'-b'x}$ into a series by the method of indeterminate coefficients.

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TRIGONOMETRY.

JUNE, 1890.

[NOTE.—State what text-book you have studied on the subject and to what extent.]

1. Express an angle of 10° in radius.

2. Express tan α, successively, in terms of each of the other trigonometric functions of α.

3. Derive the formulæ,

$$\sin \alpha = 5 \sin \tfrac{1}{2} \alpha \cos \tfrac{1}{2} \alpha; \quad \cos \alpha = 1 - 2 \sin^2 \tfrac{1}{2} \alpha.$$

4. Given tan $\alpha = m$, to find tan 2α.

5. Show that $\sin \alpha = \dfrac{2 \tan \frac{1}{2} \alpha}{1 + \tan^2 \frac{1}{2} \alpha}$.

6. Obtain a formula for expressing a side of a triangle when the remaining two sides and their included angle are given.

7. Given two angles of a triangle 68° 20′.2 and 72°, and the side opposite the first angle 2516.2 ft., to find the remaining parts of the triangle.

TRIGONOMETRY.

SEPTEMBER, 1890.

[NOTE.—State what text-book you have studied on the subject and to what extent.]

1. Express an angle of 0.25 radians in degrees.

2. Give the values of the different trigonometric functions of the following angles: $0, \dfrac{\pi}{2}, \pi, \dfrac{3}{2} \pi$.

3. Derive the formula for the tangent of the difference of two arcs in terms of the tangent of the arcs.

4. Show that the $\tan \left(\dfrac{\pi}{4} - \alpha \right) = \dfrac{1 - \tan \alpha}{1 + \tan \alpha}$.

5. Show that $\cos x - \cos y = -2 \sin (x+y) \sin \frac{1}{2} (x-y)$.

6. Show that $\tan \theta = \dfrac{\sin 2\theta}{1 + \cos 2\theta}$.

7. The three sides of a triangle are as follows: $a = 2504.5$, $b = 2526.7$, $c = 2625.2$; find the angles.

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ENGLISH GRAMMAR.

JUNE, 1890.

I. Parse the following sentence:

Why did he not come to succor us who had been the friends that had always stood by him?

II. State to which of the two conjugations—the strong (or old), or the new (or weak)—the following verbs belong: (1) *bring*, (2) *drive*, (3) *say*, (4) *begin*, (5) *tell*, (6) *hit*, and (7) *help*. Give in each case the reason for assigning it to the conjugation you do.

III. What are the relative pronouns? Give the rule for the agreement of the relative with the antecedent.

CAESAR.

JUNE 26, 1890.

I. *Translate as literally as possible:*

1. Tum demum Liscus *oratione* Caesăris adductus, quod antea tacuerat, proponit: Esse nonnullos, quorum auctoritas apud plebem *plurimum* valeat, qui privatim plus possint, quam ipsi magistratus. Hos seditiosā atque improbā *oratione* multitudinem deterrere, ne frumentum conferant, *quod* praestare debeant.

2. Quum ab his quaereret, *quae* civitates quantaeque in armis essent et *quid* in bello possent, sic reperiebat: Plerosque Belgas esse ortos ab Germānis, *Rhenumque antiquitus* transductos propter loci fertilitatem ibi consedisse, Gallosque, qui ea loca incolerent, expulisse.

3. His nuntiis acceptis, Galba, quum neque *opus* hibernorum munitionesque plene essent perfectae, neque de frumento reliquoque commeatu satis *esset provisum*, quod, deditione factā obsidibusque acceptis, *nihil* de bello *timendum* existimaverat, consilio celeriter convocato, sententias exquirere coepit.

4. Ad haec Caesar, quae visum est, *respondit;* sed exitus fuit orationis: Sibi nullam cum his amicitiam esse posse, si in Galliā *remanerent;* neque verum esse, qui suos fines *tueri* non *potuerint*, alienos occupare; neque ullos in Galliā vacare agros, qui dari, tantae praesertim multitudini, sine injuriā possint.

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5. His rebus *cognitis*, Caesar legiones equitatumque revocari atque in itinere resistere *jubet*, ipse ad naves revertitur: eadem fere, quae ex nuntiis litterisque cognoverat, coram *perspicit*, sic ut amissis circiter quadraginta navibus, reliquae tamen *refici* posse magno negotio viderentur.

6. Nam fere de omnibus controversiis publicis privatisque *constituunt*; et si quod est admissum facinus, si caedes facta, si de haereditate, de finibus controversia est, iidem *decernunt*; praemia poenasque constituunt. Si quid aut privatus aut populus eorum decreto non *stetit*, sacrificiis *interdicunt*. Haec poena apud eos est gravissima.

II. *Grammatical questions, supplementary to the paper on Latin Grammar:*

1. State the construction of all italicized words in passages 1, 2 and 3.

2. Give the principal parts of all italicized words in passages 4, 5 and 6.

3. Quote in full from the above text an example of indirect statement, and re-write it so as to make it direct.

CAESAR.

SEPTEMBER 16, 1890.

I. *Translate as literally as possible:*

1. Helvetii, omnium rerum *inopiā* adducti, legatos de deditione ad eum miserunt. Qui quum *eum* in itinere convenissent seque ad *pedes* projecissent suppliciterque locuti flentes pacem petissent, atque eos in eo loco, *quo* tum essent, suum adventum exspectare, jussisset, paruerunt.

2. Eorum fines Nervii attingebant; quorum de naturā moribusque Caesar quum quaereret, sic reperiebat: Nullum aditum esse ad eos *mercatoribus: nihil* pati *vini* reliquarumque rerum ad luxuriam pertinentium inferri, quod *iis* rebus relanguescere animos et remitti virtutem existimarent.

3. Armis obsidibusque acceptis Crassus in *fines* Vocatium et Tarusatium profectus est. Tum vero barbari commoti, quod oppidum, et *naturā* loci et manu *munitum*, paucis *diebis*, quibus

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eo ventum erat, expugnatum cognoverant, legatos quoquoversum dimittere, conjurare, obsides inter se dare, copias parare coeperunt.

4. Quod ubi Caesar *comperit*, omnibus his rebus *confectis*, quarum rerum causā transducere exercitum constituerat, ut Germānis metum *injiceret*, ut Sigambros *ulcisceretur*, ut Ubios obsidione liberaret, diebus omnino decem et octo trans Rhenum *consumptis*, satis et ad laudem et ad utilitatem profectum arbitratus, se in Galliam recepit pontemque *rescidit*.

5. Equites hostium essedariique acriter proelio cum equitatu nostro in itinere *conflixerunt*, ita tamen ut nostri omnibus partibus superiores fuerint atque eos in silvas collesque *compulerint*; sed, compluribus *interfectis*, cupidius insecuti nonnullos ex suis amiserunt.

6. Quae civitates commodius suam rem publicam administrare existimantur, habent legibus *sanctum*, si quis quid de re publicā a finitimis rumore aut famā acceperit, uti ad magistratum *deferat*, neve cum quo alio communicet: quod saepe homines temerarios atque imperitos falsis rumoribus terreri et ad facinus *impelli* et de summis rebus consilium capere cognitum est.

II. *Grammatical questions, supplementary to the paper on Latin Grammar:*

1. State the construction of all italicized words in passages 1, 2 and 3.

2. Give the principal parts of all italicized words in passages 4, 5 and 6.

3. Quote in full from the above text an example of indirect statement, and re-write it so as to make it direct.

LATIN. (*Exercises and Grammar.*)

JUNE, 1890.

I. *Translate into Latin*:

1. Caesar received[1] hostages.[2]
2. Hostages were received by Caesar.
3. Caesar leads-back[3] the army[4] to[5] the sea.[6]
4. The army was led back to the sea by Caesar.

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5. Hostages having been received, Caesar led back the army to the sea.

6. Caesar says[1] he will lead back the army to the sea.

7. (*Re-write sentence* 6, *and substitute direct for indirect statement.*)

8. Caesar said he would lead back the army to the sea.

9. (*Re-write sentence* 8, *and substitute direct for indirect statement.*)

10. Caesar formed-the-design[8] of leading back the army to the sea.

[1] accipĕre.
[2] obses.
[3] reducĕre.
[4] exercitus.
[5] ad.
[6] mare.
[7] dicĕre.
[8] consilium capĕre.

II. *Latin Grammar:*

1. Decline *obses*, *exercitus*, *mare*.

2. Decline *idem*, *nullus*, *ipse*.

3. Compare *primus*, *major*, *facilius*, *optime*.

4. Write the synopsis, active and passive, of *ducĕre* (*duxi*, *ductum*).

LATIN. (EXERCISES AND GRAMMAR.)

SEPTEMBER, 1890.

I. *Translate into Latin.*

1. The envoys[1] came[2] to[3] Caesar.

2. Caesar sent back[4] the envoys immediately.[5]

3. The envoys were sent back by Caesar immediately.

4. The envoys, who had come to Caesar, were sent back immediately.

5. Caesar said he would send back the envoys immediately.

6. (*Re-write sentence* 5, *and substitute direct for indirect statement.*)

7. Caesar says[6] he will send back the envoys immediately.

8. (*Re-write sentence* 7, *and substitute direct for indirect statement.*)

9. Caesar says, "I have sent back the envoys immediately."

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10. (*Re-write sentence* 9, *and substitute indirect for direct statement.*)

[1] legatus.	[4] remittĕre.
[2] venire.	[5] statim.
[3] ad.	[6] dicēre.

II. *Latin Grammar:*

1. Decline *castra, locus, iter.*
2. Decline *facilis, integer, totus.*
3. Compare *facilus, inferior, acriter.*
4. Write the synopsis, active and passive, of *nuntiāre* and of *mittĕre.*

GEOGRAPHY.

JUNE, 1890.

1. Bound the State of Alabama; what is its seaport and how is it situated?
2. Bound British India; give the situation of two cities in it; describe two rivers in it, tell where each rises, its course and where it empties.
3. Where are the West Indian Islands; what waters lie about them? Give the names and situations of such of the islands as you can.
4. Describe the river Rhine; where does it rise; what is its course; where does it empty; and what countries does it pass through or by?
5. Where are the following cities: Lexington, Venice, Melbourne, Minneapolis, Vera Cruz, Bahia?
6. Bound Denmark; what is its capital and how is it situated?
7. Give the names and situations so far as you can, of the seaports in Europe and Africa on the east side of the Atlantic Ocean.

GEOGRAPHY.

SEPTEMBER, 1890.

1. Bound the State of New Hampshire; give the names and situations of two towns in the State; and of two rivers in the State or on its borders.

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2. Bound Siberia; to what government does it belong; give the names of two rivers in the country, tell the course of each and where each empties.

3. What Islands are in the Mediterranean Sea? Describe the situation of such as you can.

4. Describe the river Oronoco; tell where it rises, its course and where it empties.

5. Where are the following cities: Los Angeles, Atlanta, Buenos Ayres, Sydney, Naples, Quebec?

6. Bound Austria, what is its capital and how is it situated? What large river passes entirely through the country?

7. Give the names and situations so far as you can of the seaports of America on the west side of the Atlantic Ocean.

JUNE, 1890.

I. Describe the settlement of Carolina and its government.

II. Give an account of the Stamp Act, the Massachusetts Bill and the Transportation Bill.

III. By what treaty was the Revolutionary War ended and what were its terms?

IV. What was the Hartford convention?

V. What were the causes and the chief conquests of the Mexican War?

VI. Give an account of the impeachment of President Johnson.

N. B.—The dates are to be given wherever possible.

SEPTEMBER, 1890.

I. Give an account of the career of Captain John Smith.

II. Describe Wolfe's capture of Quebec; in what war did it occur and what treaty ended the war?

III. Give an account of the Battles of Lexington, Germantown and Princeton.

IV. When and how were Louisiana and Florida acquired?

V. What was Clay's Omnibus Bill?

VI. Give the principal causes and results of the civil war.

N. B.—The dates are to be given wherever possible.

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